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THE CLOSING YEAR.

It must be a source and cause of general satisfaction that the year just closing has a much brighter outlook than it had at the start. The improvement is so general and so varied it is hard to signalize any one prominent condition, but it might, perhaps, suffice to say that the year which began with a foreign indebtedness of from three to five hundred million dollars has seen that burden literally wiped out. The penalty and punishment of wild speculation not only wrought financial havoc, but during part of the year lay an incubus on industry and commerce hard to be borne. But the last three months have seen a striking change, for with easier times in the money and stock market has come a decided renewal of industrial activity and confidence. Prices all around have been brought to a better level, except in the case of some raw agricultural materials, so that while one or two American products are at high prices, the lower average has stimulated export trade, and once more the high water mark has been reached. In every way the check of the past year has been a good thing, and no real prosperity has been touched by it. So far as electrical growth is concerned, the year has been an active one all around, in discovery, application and trade, as our Index for the volume concluding with this issue and appearing herewith, shows; and the forecast even by the most cautious man cannot but be cheering as to 1904. A Presidential election year never, so far as we are aware, witnesses a boom; but booms are the last thing this country wants. The best condition is that of healthy normal activity, and certainly no good reason can be seen why that should not prevail throughout the coming year. At the same time, as a people we Americans have little cause to complain of 1903.

SINGLE-PHASE TRACTION MOTORS.

It is with great pleasure that we present on another page a valuable paper on this topic from the pen of Mr. B. G. Lamme. It is a review of the present situation which can be studied with much profit, although we regret that the author did not at this time see his way clear to a definite description of the very interesting motor which he has succeeded in developing. From a theoretical standpoint, Mr. Lamme has done good service in laying stress on the essential kinship of continuous-current and alternating-current motors, grouping together as he does even ordinary series-wound motors and induction motors provided with a commutator. It is a clean, sane note of common sense rising above the Babel of discordant equations that has made alternating motor practice a region of horror to the ordinary man. He might well have gone further and remarked that given an alternating motor, it makes precious little difference in the fundamental principles of its action whether the current enters the armature by brushes or by electromagnetic induction. Mr. Lamme discusses at some length the nature of the losses incurred in direct-current and alternating-current motors, showing clearly why in the latter somewhat greater losses may be expected, and how these are, in the long run, compensated in large measure by gain in the efficiency of the regulating appliances. Of course, the question of power factor is always to the fore, but in spite of the low power factor at starting shown by the type of motor which Mr. Lamme is discussing, the very important fact remains that it appears possible to start and accelerate the car without demanding an excessive current.

This fact comes out with especial clearness in the tests of the Finzi motor, which we have recently published, where the volt-amperes during the starting and acceleration are actually plotted. It may fairly be taken for granted that if an alternating-current railway motor is thoroughly good in other respects, nobody will be scared away by a low power factor merely while the motor is starting. And at load the power factors of the motors in question are amply high, decidedly higher than those customarily found in pure induction motors. While we concur with Mr. Lamme that the art of commutation has advanced wonderfully in the past decade, we cannot agree that because a direct current of x amperes can be successfully commutated and alternating current periodically varying from $+ x$ to $- x$ can also be successfully commutated. That is a question of fact, with all the data now at hand tending to show greater difficulty in dealing with the alternating current. If Mr. Lamme, Dr. Finzi, Eichberg and Winter and the rest make good in actual working service their claims of sparkless commutation they have not merely moved along with the art, but have made the greatest step forward since commutation was invented, and deserve correspondingly great credit for their success. Nothing but some little experience with motors operating under commercial conditions will tell the whole story as to sparking, but we may incidentally remark that if it is feasible to build a sparkless alternating-current railway motor it is *a fortiori* practicable to build stationary motors along the same lines, which would make material changes in the art of alternating-current distribution. Indeed, one of our English contemporaries has gone so far as to say that the Winter-Eichberg experiments very clearly indicate the near and forced retirement of the polyphase stationary motor from that part of the commercial field which it now occupies.

We are particularly interested to note that Mr. Lamme comes out boldly in favor of urban traction by alternating motors instead of relegating them to long-distance and interurban work. This is carrying the war into Africa with a vengeance, but the regulation of these alternating motors for low speeds is more efficiently accomplished than in ordinary direct-current working. Just how the comparison would stand in regular running one can hardly say off-hand, but it is reasonably clear that if the type of alternating motor concerned anywhere nearly comes up to the hopes of its friends, it is capable of giving direct-current motors a hard rub almost anywhere. Of the beneficient effect of alternating-current motors on the modern problems of distribution there is no doubt. The necessity of supplying direct current to the cars at distances compelling the transmission of alternating currents has been a dreadful incubus upon electric traction. It certainly appears that we already see the beginning of the end, and that in the future work can be conducted upon broader lines than heretofore. However well alternating motors may prove to work on urban systems, it is in the larger work that they are most needed, and it is doubtless there that they will for the present find the most useful application.

THE FLAMING ARC LAMP.

The arc lamp employing impregnated carbons has recently been coming to the front, and to a limited extent has been used in Germany on commercial circuits with satisfactory results. These arcs have beyond any doubt an enormous luminous efficiency, two or three times as great as that of ordinary arcs, with a better color quality and a somewhat lower intrinsic brilliancy. But they give a species of flaming arc, the fumes from which introduce a complication of no small import. They present in this respect a problem not unlike that of the enclosed arcs eight or ten years ago. Many ingenious attempts to avoid the difficulty have been made, but it is too early yet to look for complete success. Still the class is a promising one, well worth persistent attempts at improvement. An arc with a light of good color produced with an expenditure of less than half a watt per candle-power certainly justifies interest, and is a prize not to be passed by.

In this instance America, unfortunately, cannot count too much upon help from foreign results, for in arc lighting the lessened cost of labor abroad plays a very important part. The success of the enclosed arc in this country is a monument to the forbidding seriousness of American labor conditions. Its light is undeniably produced at considerably less efficiency than that of the open arc and its color is not altogether prepossessing, yet it so reduces the labor account that it has become an economic necessity. It has advantage in steadiness and in the distribution of light to be sure, but the lessened care is its real *raison d'être*. The arc with composite carbons has to face in this country, then, special conditions, and how far it may be possible to strike a compromise between efficiency on the one hand and an increased demand for attention on the other, remains to be seen. We are inclined to think that a commercial solution of the difficulty is attainable, and look forward to it with interest. But meanwhile electric lighting is a growing art and the output of standard arcs and incandescent lamps is increasing with great rapidity. Long after proposed new illuminants have passed into thoroughly successful use, they will have to struggle to make any serious impression on the art as a whole. Meanwhile we tender our respects to the experimenters and wish them success. It certainly is high time for improvements in efficiency, for electric lights demand yearly an enormous output of energy, a large part of which ought to be suppressed.

THE N-RAYS AND RADIOACTIVITY.

It would be hard to mention an important scientific discovery which has attracted less public attention than Blondlot's beautiful researches on the rays which he has thus named. The daily press, which is usually generous to striking discoveries, seems hardly to have learned that N-rays exist. And yet no work within a decade gives richer promise of important results. M. Blondlot's latest discovery is that radiants which give out N-rays can communicate a similar variety of radioactivity to some neutral bodies upon which the N-rays fall. The phenomenon was discovered while concentrating the rays by a quartz lens upon a phosphorescent screen, when it was found that the N-radiation persisted with the lens as a source after the original source was removed. Following up this clue, it turned out that various other substances became temporarily active after exposure to N-radiation. A sheet of lead, for example, became active on both faces after exposure to the rays, producing an effect that might easily have been mistaken for penetration of the lead by a less experienced observer. In short, a set of phenomena closely similar to so-called induced radioactivity are produced by these extraordinary N-rays, which have so commonplace an origin as a Welsbach burner, and are reflected and refracted like any other kind of radiant energy. The N-rays appear to form a connecting link between the ordinary phenomena of light and the singular effects of radioactivity which have set the scientific world agog within the last year or two. No explanation of the latter can now be regarded as complete unless it takes full account of the former and their relation to ordinary radiation. A linkage of this sort is invaluable in preparing for generalization the great mass of experimental data that has been accumulated. The complete emission spectrum of a radiating substance has thus far never been determined, and until this can be done the phenomena which belong to the radiation cannot fully be determined. The study of the N-rays has opened a new field of investigation which seems likely to yield some very important theoretical results.

GAS POWER FOR CENTRAL STATIONS.

At last Friday's meeting of the American Institute of Electrical Engineers, a paper was read by Mr. J. R. Bibbins on the subject of gas engine power in central stations, in which the claim is made that gas engines are both cheaper to operate and easier to operate than steam engines for the purposes of power generation. Thirteen gas engine plants are analyzed, the largest gas engine unit having a rated full-load capacity of about 630 kw. The average size was about 230 kw. These are relatively small engines for modern power plants. The mean cost of gas is stated to have been 1.4 cent per kw-hour, although it is claimed that at a reasonable price for gas of 20 cents per 1,000 cubic feet, the cost would have been only 0.875 cent per kw-hour. It was also claimed that a test of comparative operating economy was made on a certain steam and gas station, lasting several months under commercial conditions. The cost for gaseous fuel in the gas station is given as 0.84 cent per kw-hour, while the cost for coal in the steam station is given as 1.36 cent per kw-hour, these figures thus representing a saving of no less than 39 per cent. in the cost of fuel by gas.

It is admitted that the thermic efficiency of a good gas engine is higher than that of a good steam engine, and it is also generally admitted that a gas engine of, say, 500 hp, consuming fairly cheap natural gas, is cheaper to operate than a steam engine of similar power at the ordinary price of coal; but there is very little yet known of the relative economy of large steam engines and large gas engines in this country. A gas engine is a simpler machine than a steam engine, and has fewer auxiliary parts, especially where natural gas is available. Moreover, we may expect the gas engine to supplant the steam engine in large sizes in the future. For the present, however, we must be content with the great advance that the gas engine has made in recent years up to its present moderate size. When the paper by Mr. Bibbin and the discussion thereon is printed in another issue, we shall return to this interesting subject, which lately has so rapidly come to the front.

NEW LIGHT ON RADIUM.

So much of the previous work on radium has been wildly speculative and based on undemonstrated electrical hypothesis that it is positively a great mental relief to find so clever an investigator as Sir William Ramsay settled down to an attack on the mystery along sane and systematic lines. The newspaper reports on his London lecture, on which we commented a few weeks ago, are full of speculations on the transmutation of metals and such like pleasantries, but stripping the report of useless verbiage the facts brought to light by later accounts appear to be about as follows: First, radium salts, among other things, give off spontaneously a heavy gas which possesses the radioactive properties of the parent substance. Second, this gas loses its radioactive properties and apparently disappears in a month or so. Third, in so disappearing its spectrum, in itself unidentified, fades out and is replaced by the helium spectrum. As regards this last fact, there can be no manner of doubt, for the helium spectrum is absolutely characteristic and could not be mistaken for anything else, even by the merest tyro, let alone an experienced investigator. Granted the helium, what was its actual source and its relation to radium gas and to radium itself?

Helium itself is a well-defined, stable and rather inert gas nearly as light as hydrogen, present in large amounts in the solar envelope, in a number of stars and in small quantities in a few rare minerals in volcanic regions. From these sources the atmosphere derives a meagre supply. The first matter of importance is the relation of the helium to the radioactive gas which it seems to replace. Is the latter a condensation or a compound of helium? Either hypothesis would be plausible enough, but the former would indicate new relations, the latter old and familiar, though interesting ones. On the one hand, a heavy gaseous compound of helium would be more than likely to be unstable; on the other, a complicated condensation thereof would also presumably be unstable, and in either case a change in the predominant spectrum would probably occur in the breakup of the heavy gas. The most important feature of the case is that the radium gas has in the main the radioactive properties of radium, while the helium which results has not. There is, therefore, in the phenomenon a clue to the real nature of radioactivity, since one can investigate it in a gas of definite character, giving a definite though unknown spectrum and decomposing with the evolution of a known and stable gas. One is tempted to ask whether radioactivity is not, like phosphorescence, a concomitant of decomposition. At all events, the careful study of this change in its quantitative relations is likely to throw a flood of light on the nature of radioactivity, and the relation of the hypothetical electrons to the phenomena observed. And when it is definitely decided whether radium gas is a condensation of helium—He_n; or, let us say, helium X-ide $He_n X_m$—a very long step will have been taken toward unraveling the mystery of radium itself—a consummation most devoutly to be wished, if only to deprive the yellow journal writer of the opportunity that the present lack of knowledge affords for sensational speculation.

It must be remembered that when one hears the word radium, it really means a salt of radium, generally the chloride or bromide, since no one has yet obtained enough of the precious substance to risk in attempts at reduction to the metallic form, so far as we have yet heard. In fact, the metal itself when obtained might not possess radioactive properties at all, or might only possess them in a small degree, and it might very possibly turn out that radioactivity is characteristic of the decomposition of an unstable radium salt. All this, of course, is pure speculation, but the really pertinent question is the relation of the radium-helium gas to the salt of radium (so-called), which gives it off. It has yet to be shown that radium is a chemical unit in the ordinary sense. It is quite possible for a substance to knock about for years as an element of known spectrum and atomic weight and then to be split up into two or more components, each quite characteristic chemically. Such was the case with didymium. This being so, it is certainly not impertinent to inquire whether the radium gas is a general emanation from the radium salt as a whole, or from a possible component. Comparison of the spectra will probably give some clue to the facts—about the only clue possible, until radium can be obtained in reasonable quantities. Enough has been said to indicate that the derivation of helium from radium gas gives one no proper license to talk about the transmutation of metals. That all the so-called elements are derived from some parent substance or substances is an old theory, and one which in itself is probable enough, but all the data heretofore at hand indicate that the resolution of an element into its components is unlikely to be a simple or spontaneous process. Hence, it is well to go slowly in this radium-helium affair. The demonstrated facts taken merely at their face value are interesting and important enough without indulging in speculation. We hope that Ramsay will push his investigation vigorously, for it seems far more likely to clear up the radium mystery than any other line of research which has yet been tried. It is a great pity that the material is so nearly unattainable, for its scarcity at present puts ordinary chemical methods quite out of the game and forces reliance on methods that necessarily leave many questions unanswered.

Test of Westinghouse Turbine.

On December 21 an economy test of a 1,250-kw Westinghouse steam turbine generator set for the Interborough Rapid Transit power house was made at the Westinghouse Machine Company's shops. The net results showed a steam consumption of 15 pounds per electrical horse-power with 27 in. of vacuum, and 14½ pounds, with 28 in. of vacuum; barometer reading, 30 in.; steam, dry saturated, delivered to the turbine throttle at 150 pounds gauge pressure. At the close of this economy test the automatic safety stop, with which all Wesinghouse turbines are now equipped, was tested by holding down the governor lever so that the speed of the turbine was uncontrolled. The turbine, of course, accelerated its speed immediately, and just before the rate of speed reached 10 per cent. above the normal rate, the safety stop automatically released and shut off the steam supply. This was followed by a test for regulation under extreme conditions, the full load being thrown on and off instantaneously several times. The variation in the speed of the unit between no load and full load, as indicated by the change in tone of the note given out by the generator, was barely perceptible.

December Meeting of the A. I. E E.

Four papers presented last Friday at the December meeting of the American Institute of Electrical Engineers. Two are reprinted in full elsewhere in this issue, namely, the paper by Mr. George H. Lukes, entitled, "Overhead High-Tension Distributing Systems in Suburban Districts," and that of Mr. W. C. L. Eglin, entitled, "Safeguards and Regulations in Operation of Overhead Distributing Systems." A paper was presented by Mr. J. R. Bibbins, entitled, "Gas Power for Central Stations," setting forth the advantages of operating central stations in connection with gas works, and included a number of curves of tests of gas engines and tables of operating costs and profits of the typical gas power plant equipment. We shall return to this paper in another issue.

Mr. E. J. Bechtel, in a paper entitled, "Automatic Apparatus for Regulating Generator and Feeder Potentials," described a type of such apparatus used in the station with which he is connected. These regulators are of the boosting transformer type, having a secondary winding in series with the circuit and divided into small sections which are capable of being automatically cut in or out step by step, as the conditions require, to maintain a desired voltage at the individual feeder terminals. They will regulate up to ten volts above or below that of the bus-bars. The paper includes a diagrammatical representation of the apparatus and reproductions of records.

The greater part of the discussion of the evening was on the paper by Mr. Bibbins, which is reserved to be printed in another issue with his paper. In discussing the paper by Mr. Eglin, Mr. H. M. Geer said that unnecessary blowing of fuses can be practically eliminated by a systematic method of fusing lines according to the connected load, and checking up the connected load on all fuses at regular intervals. The burning of cross arms due to leakage of current from the cases of iron cut-out boxes in wet weather may be reduced to a minimum by mounting the boxes on glass supports. Fuses should be restricted to the least heavily loaded branches, depending upon circuit-breakers or station fuses for protection from accidents on feeders or heavily loaded mains. Another class of accidents has been much diminished by first-class line construction combined with a system of regular inspection, which if made at intervals of one or two months, will often reveal prospective causes of trouble due to the erection of new buildings, stringing of wires by other companies with too little clearance, etc. Interruptions due to burnt-out transformers may be minimized by the use of lightning arresters located near the larger transformers, since troubles from overheating are very infrequent.

Mr. Geer said that a cross arm similar in dimensions to the one described by Mr. Lukes has been in use in Chicago for a number of years with excellent results. Double-petticoat glass insulators, having an outside diameter of about 4½ inches, have been used in Chicago on 4,000-volt, three-phase circuits for several years with excellent results, but the deep-groove, double-petticoat insulator used on standard 2,000-volt lines would probably serve the purpose equally well, as far as insulation is concerned. In Chicago, accidents due to lighting wires falling across telephone wires have been almost unknown.

Mr. G. T. Hanchett said that one of the most prolific causes of accidents on lines running in suburban districts is the grounding wire on trees. He has seen limbs 6 or 8 inches in diameter burned completely in two by wires, and also wires burned in two from resulting arcs. Mr. H. A. Wagner said that latest practice has shown the desirability of numerous lightning protecting devices installed away from the station, in addition to those also used in the stations and substations. In an experiment made on a railway in western Pennsylvania a lightning arrester were placed on every pole, care being taken to see that all ground and other connections were properly made. Observations made on each arrester after every storm showed that with four arresters per mile per conductor practically every lightning discharge was taken care of.

Mr. Paul M. Lincoln advocated relying only on the insulator for the line insulation. Burning out of pins can be prevented in two ways, one being to make the pin a perfect insulator and keep it so, and the other and better method to make it a conductor, as in that case the escaping current cannot generate sufficient heat to cause burning. Mr. M. P. Ryder said that his experience is that it is not safe to depend upon any wire insulation, whether of rubber or weather-proof. He considered, however, that weather-proof wire is a great protection in dry weather, and saves a good deal of trouble which otherwise would occur in service, and in this he was supported by several others during the discussion. He considered that lightning arresters are not an absolute protection against lightning, and that it does not pay to use a great number of them, confining their use to the station end of the circuit and to the terminals. Ralph D. Mershon and Mr. Fremont Wilson very strongly condemned the use of weatherproof wire, and the latter criticised severely the Yonkers line of the North River Lighting Company, both on account of lack of proper lightning protection and from grounding on trees. He had noticed children taking shocks from trees, and in testing the circuit himself, he received a severe shock. Professor Sever dwelt on the danger from the crossing of high-tension wires with telephone and signal wires, and said that within a few days a 16,000-volt feeder wire at Joliet, Ill., fell across a telegraph wire and caused fires six miles in one direction and nineteen miles in the other, burning two stations to the ground and setting fire to the switchboard of the telegraph company in Joliet. He had found that there are about 260 fires on the Underwriters' records caused by the crossing of signal and telephone wires with railway and other high-power circuits.

Mr. H. G. Stott said that the grounding of any part of the secondary network, especially the neutral wire, is the best form of protection obtainable. When lightning strikes a high-tension line the oil transformer forms one of the best lightning protectors. Referring to a query why a transformer primary fuse will blow in a lightning storm, he said this is caused by the lightning jumping either between the turns of the transformers and short-circuiting the transformer, or if the secondary is grounded, jumping through the light insulation to that ground. He emphasized the desirability of concentrating all automatic apparatus in the power house or in substations. Mr. W. C. L. Eglin stated that he has experimented with many devices to keep wires from trees, but all have failed. He agreed with Mr. Mershon that weatherproof insulation is a farce, and should not be permitted, and he also agreed that the line insulation should be provided in the insulator and not in the pin, the latter being only expected to support the insulator. His experience with lightning arresters has been that in the stations they are more effective than on the line, for the reason that they are kept in better condition. Mr. Mershon concurred with several speakers who condemned the use of rubber gloves; they are an actual source of danger, as the men will depend upon the gloves and yet will not keep them in proper condition. Mr. Geer said that one point favoring the use of weatherproof wire is that in case of actions in court the fact that there is even weatherproof insulation on wire is of decided advantage to the company complained of. As to lightning protection, the results of experiments have shown that the average distance apart of arresters on the line should be about a quarter of a mile. In some cases, however, transformers have been burned out located not more than two or three hundred feet from a lightning arrester. In running through trees, some trouble may be obviated by a little trimming of the smaller limbs, or giving the wire somewhat more than normal sag, and in some cases it is advisable to use a porcelain tube about two feet long secured to a limb. Mr. Fremont Wilson cited a case where after lightning arresters had been placed a distance apart of a quarter of a mile no further damage from lightning occurred.

Telephone Spring Jacks.

As we go to press, telegraphic advices from Chicago inform us that the Western Electric suit against the North Electric Company, for infringement of Scribner and Warner patents relating to long and short springs in spring jacks for telephone switchboards has been dismissed and judgment for costs awarded against complainant.

Montreal, the Greatest Centre of Transmitted Power.—IV.

(*Concluded.*)

BY ALTON D. ADAMS.

THE CHAMBLY POWER HOUSE.

AT Chambly two sets of bus-bars are provided at the switchboard for the two-phase, 2,200-volt current from the generators. The low-tension side of the step-up transformers there may be connected with either of these two sets of bus-bars by means of motor-operated oil switches. Each of the eight main generators may be connected by its switch with either set of these bus-bars, but these generator switches are manually operated. The generator

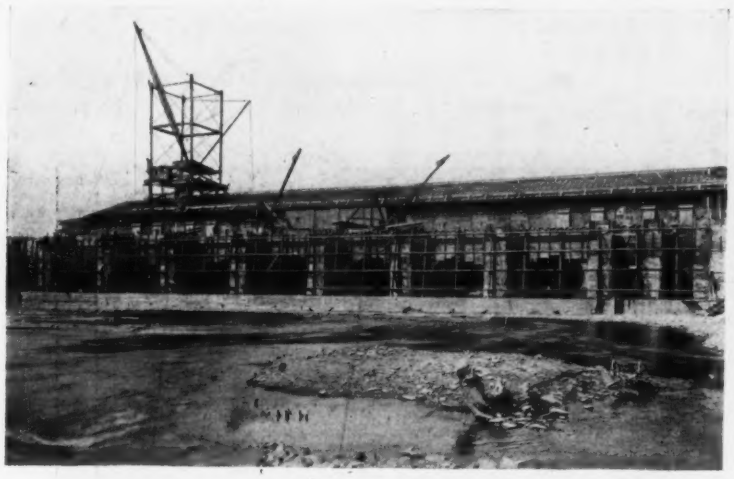


FIG. 1.—FRONT VIEW OF CHAMBLY POWER HOUSE.

switches, like those for the transformers, are of the oil type, with a separate brick and stone compartment for each pole. To provide air under pressure for the ten air-blast transformers, four blower sets are employed, each consisting of a 40-hp, 550-volt induction motor, direct-coupled to a pair of blowers, one at each end of the motor shaft.

Of the eight alternators at Chambly, four were made by the General Electric Company and are rated at 2,200 kw each, at 2,200 volts

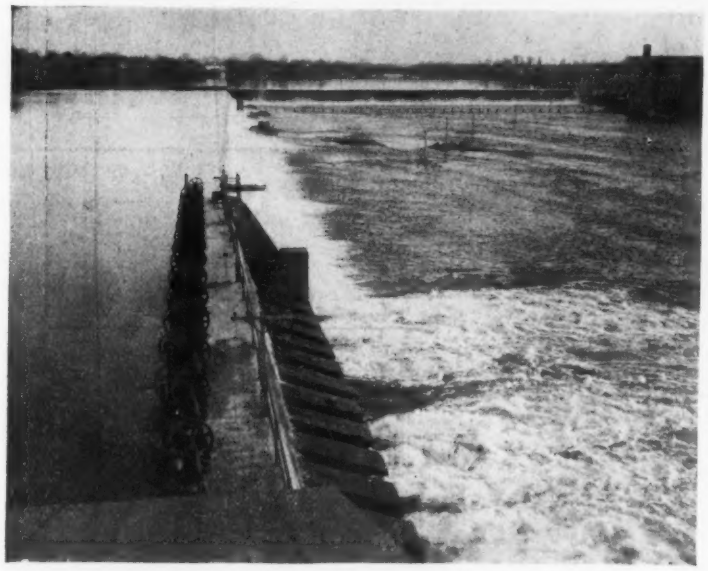


FIG. 2.—VIEW UP STREAM FROM POWER HOUSE.

two-phase. The other four alternators are of the Stanley make, and each has a capacity of 2,000 kw, at 2,200 volts two-phase. All of these generators operate at a frequency of 63 cycles per second, this number of cycles having been adopted as a compromise between 60 and 66 cycles, both of which frequencies were formerly found in the water power stations that now contribute to electrical supply in Montreal. By lowering the speed of revolution a little for some generators and raising it a little for others it became possible to operate the several water power stations in multiple at 63 cycles per second. Each of the eight alternators at the Chambly station is direct-connected to the horizontal shaft of four McCormic turbine wheels mounted together. Each of these turbines is 51 in. in diameter, and under the available head of 31 ft. of water operates at about 152 r.p.m. Two exciters, rated at 300 kw and 125 volts each furnish current for the magnet coils of the alternators. Each of these exciters is direct-connected to the horizontal shaft of two 27-in. turbine wheels, which are rated at 450 hp, and operate at 250 r.p.m. under the water head of 31 ft. The set of wheels driving each main generator and each exciter is regulated in speed by a Lombard governor. Four of the above alternators, those made by the General Electric Company, have stationary armature coils and

FIG. 3.—SETTING THE PENSTOCK TUBES.

internal revolving magnets. In the case of the four Stanley alternators the armature coils are stationary, but this is also true for the single magnet coil of each machine, and the only revolving parts are the masses of iron that complete the several magnetic circuits. Eight alternators and the two exciters form a single row that extends almost the entire length of the Chambly power house, and their shafts are all parallel. As may be noted from the above, the total rated capacity of alternators at Chambly is 16,800 kw.

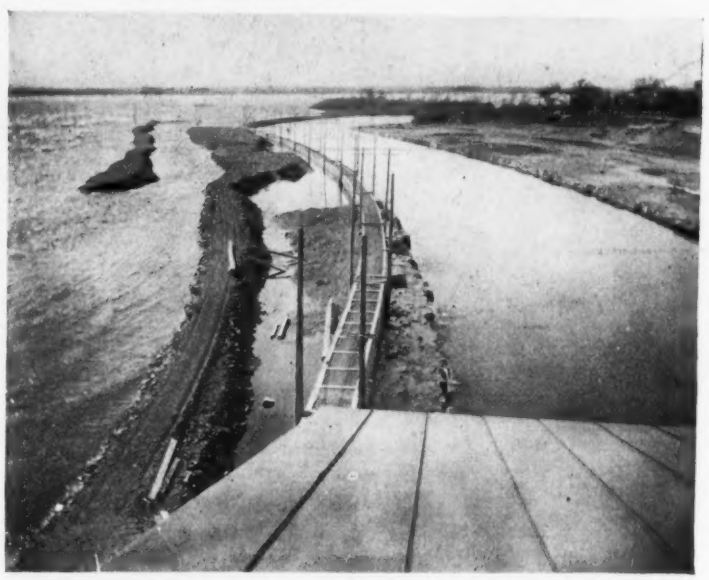


FIG. 4.—VIEW DOWN STREAM FROM POWER HOUSE.

The room thus occupied by the generators is about 277 ft. long and 28 ft. wide. At nearly the same level with the generator room and on its upstream side, but separated from it by a water-tight wall of concrete 4 ft. thick, are the compartments for the horizontal turbine wheels. The shafts of the main wheels are located 17 ft. above the tail-water level, and each shaft passes into the generator room through a water-tight bulkhead of cast iron. From each pair of 51-in. turbine wheels, of which there are two pair on each shaft, a draft tube of 10 ft. 3 in. diameter passes down to the tail water. Top, bottom and sides of the wheel chambers are all of concrete, and the roof

of these chambers rises on its outside to an elevation of 19.5 ft. above the floor of the generator room. The concrete floor thus formed by the roof of the wheel chambers is about 20 ft. 4 in. wide between the plain of the wall on the upstream side of the generator room and the upstream wall of the upper part of the station. This elevated floor over the wheel chambers is about 305 ft. long and carries the switchboard in its central portion and the transformers.

Underneath that particular portion of this elevated floor that is nearest to the generator room, parallel to that room, and directly over the water wheels that are nearest to the wall that separates the generator room from the wheel chembers, there is a tunnel 6 ft. wide and 6.5 ft. high. Into this tunnel, which runs beneath the switchboard and the transformers, cables between the switchboard, transformers and generators are brought Along the top of the concrete wall that separates the generator room from the wheel chambers there is a row of steel columns that extend to the lower cord of the roof trusses. These columns serve to support a track for one end of the traveling crane, and the track for the other end of this crane is carried by steel columns along the downstream wall of the station. This crane is provided with electric motors for both hoisting and conveying purposes, and sweeps the entire generator room.

In effect the water power station at Chambly forms a part of the dam across the Richelieu River by which the head of water is maintained. This dam, considered as a whole, starts from the west side of the river in a direction approximately at right angles with the bank and continues thus until it is more than half-way across the stream. Then the dam makes a turn at approximately right angles, and continues down stream nearly parallel with the east bank for perhaps 1,000 ft. At the end of and at nearly right angles to this second part of the dam comes the power house, which extends to the east bank, and thus completes the dam. About 30 ft. of the length of the water power station rests on the bank, and the remainder of its 308 ft. of total length is built up from the bed rock of the river. Up and down stream the width of the station foundations is 82 ft., and this narrows to about 72 ft. at the floor level of the generator room and the wheel chambers. On a level with the top of the arches over the wheel chambers, whence rises the upper part of the wall on the upstream side of the station, its width shrinks to 51.5 ft. over both outside walls. The steel roof trusses span these walls and the lowest cords of these trusses are 34.5 ft. above the floor of the generator room. Foundations of this power station are of concrete up to and including the floor of the generator room on the downstream side, and up to and including the roof of the wheel chambers. These concrete wheel chambers have a total length of 42.5 ft. up and down stream, and of this length 20.5 ft. is outside of the upstream wall of the top portion of the power house. Above the concrete foundations the walls of the power house at Chambly are of brick with vertical steel columns set into them to support the roof trusses. Beneath the upstream side of the power house there are ten wheel chambers for the eight sets of large wheels and two sets of smaller ones. Beneath the downstream side of the power house there are seventeen archways through which the draft tubes of the several sets of wheels pass between the wheel chambers and the tail water.

Each pair of the 51-in. turbines has its own draft tube of 10 ft. 3 in. diameter, and each pair of 27-in. wheels has a draft tube of approximately 5 ft. diameter. There is thus one archway under the generator room for each of the larger draft tubes, and also one archway for the pair of smaller tubes.

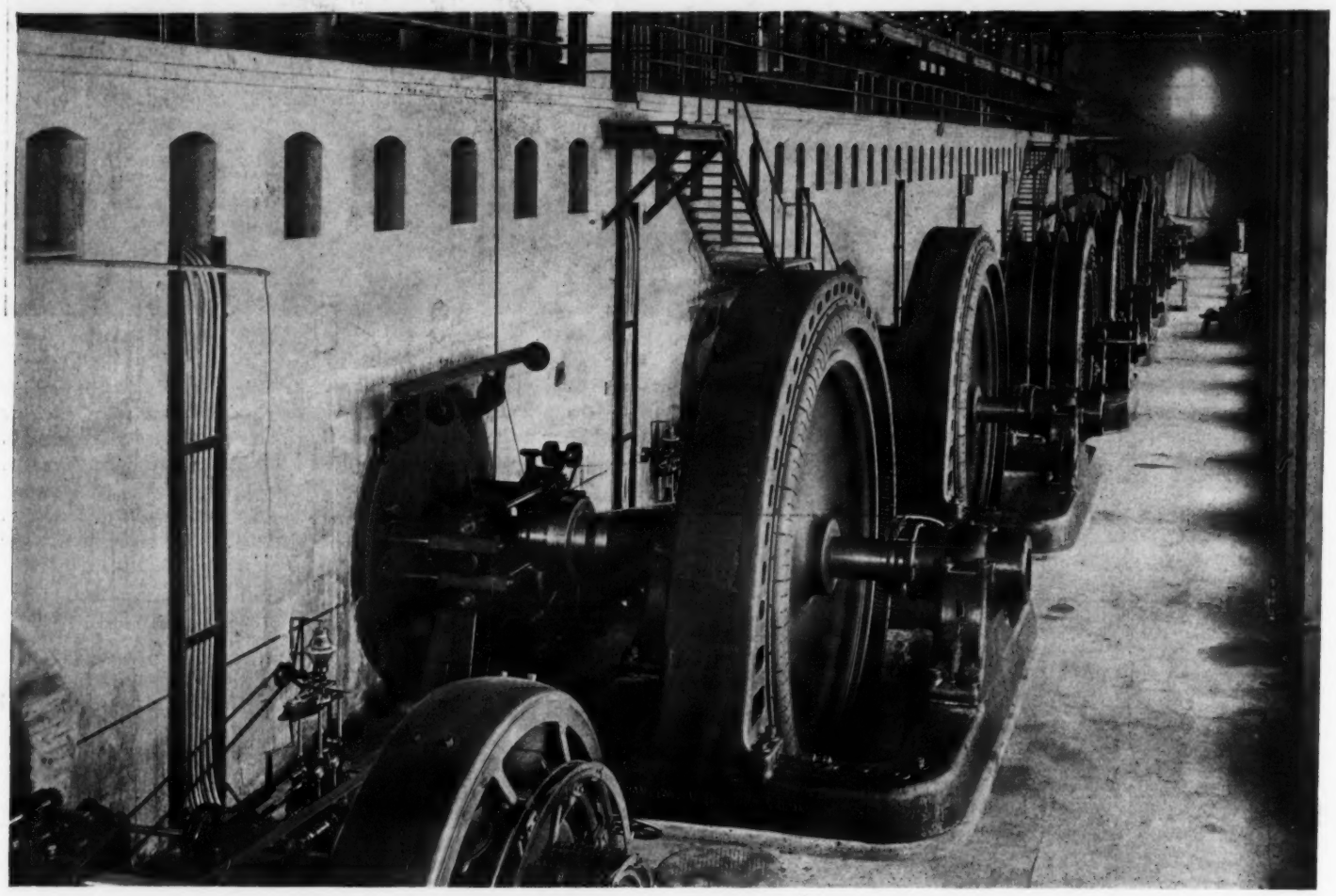


Fig. 5.—Interior View Chambly Power House.

At the upstream end of the wheel chambers is the steel rack to keep ice and other floating objects away from the wheels. This rack is 269 ft. long and has a vertical height of 23.5 ft. From the foregoing it may be seen that the flow from head to tail water is directly underneath the power house from the upstream to the downstream side. As at first constructed, the wheel chambers contained the open turbines, but this has recently been changed and a steel penstock with gate has been provided for each set of wheels. Near the river end of the power house a set of waste gates in the dam or forebay wall, through which water may be drawn off into the main channel of the river, are located. The long portion of the dam running up and down stream, as well as the shorter portion that crosses the main channel, was originally built entirely of concrete, save that small iron rods were buried at intervals in the mass to increase its strength. Results with this construction have not been entirely fortunate. Some time after the completion of the dam, that

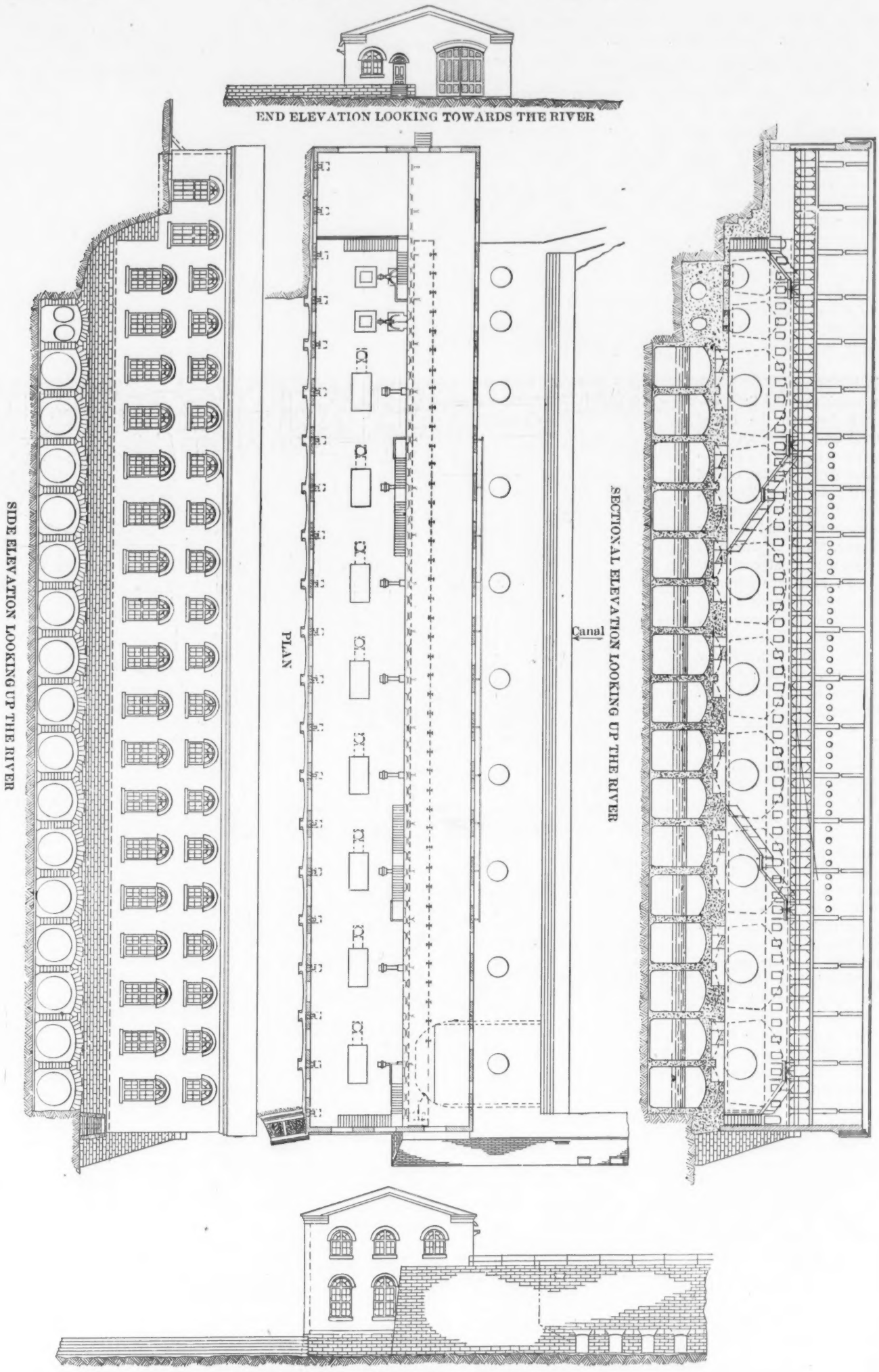

END ELEVATION LOOKING TOWARDS THE RIVER
SIDE ELEVATION LOOKING UP THE RIVER
PLAN
Canal
SECTIONAL ELEVATION LOOKING UP THE RIVER
END ELEVATION LOOKING FROM THE RIVER

FIG. 6.—PLAN AND ELEVATIONS OF POWER HOUSE FOR CHAMBLY MANUFACTURING COMPANY.

portion containing the waste gates, near the power station, gave way and had to be rebuilt. On December 1, 1902, that portion of the dam across the center of the main river channel broke loose and moved some rods down stream in a mass, leaving a clear gap from the bed of the river up for the escape of the water. This detached portion of the dam, bristling with the iron rods that were intended to hold it together, still stands alone in midstream, a monument to its builders. Repair of this break has only recently been completed, and meantime great loss has been sustained through inability to operate the 16,800-kw capacity of generating equipment at the power station. While a new section of dam was being constructed in the gap at midstream, a wide apron of timber and stone has been laid along the side, next to the main river channel, of that part of the dam that extends for more than 1,000 ft. up and down stream. As this very large piece of concrete dam work stands, whether from improper design or poor materials, it may fairly be said to illustrate to a conspicuous degree the way not to do it.

Lachine Rapids on the St. Lawrence River, between the Island of Mantreal and the south bank of the stream, is the site of the second water power station owned and operated by the Montreal Light, Heat & Power Company.

At this station the head of water on the wheels, about 16 feet, was obtained by an unusual construction. The St. Lawrence River at this point passes through a long series of rapids with no great fall i nany one place. To render a portion of the water available for power purposes, a large breakwater, perhaps a mile in length, was constructed up and down river through the rapids between the island of Montreal and the south bank, but nearer the former. At a point nearer to the down stream than to the up-stream end of this breakwater a power station and dam was thrown across that portion of the river between the breakwater and the Montreal bank. Water in that portion of the St. Lawrence between the breakwater and the Montreal shore must obviously pass through the power station on its way down stream, and in thus passing it is made to fall through a long row of water wheels. The head of water being so small, only 16 feet, it was necessary to devise some way in which a reasonable speed of revolution could be obtained for the electric generators. The plan adopted was to use single vertical turbine wheels, and to drive each generator direct connected to a long horizontal shaft, which is in turn connected by bevel gears with the vertical shafts of six turbine wheels. As originally designed each horizontal shaft with its connected generator had a speed of 180 revolutions per minute. Each of the 51-inch vertical turbine wheels geared to this horizontal shaft had a speed of about 77 revolutions per minute.

The water-power station at Lachine Rapids was designed for twelve generators of 750 kw capa-

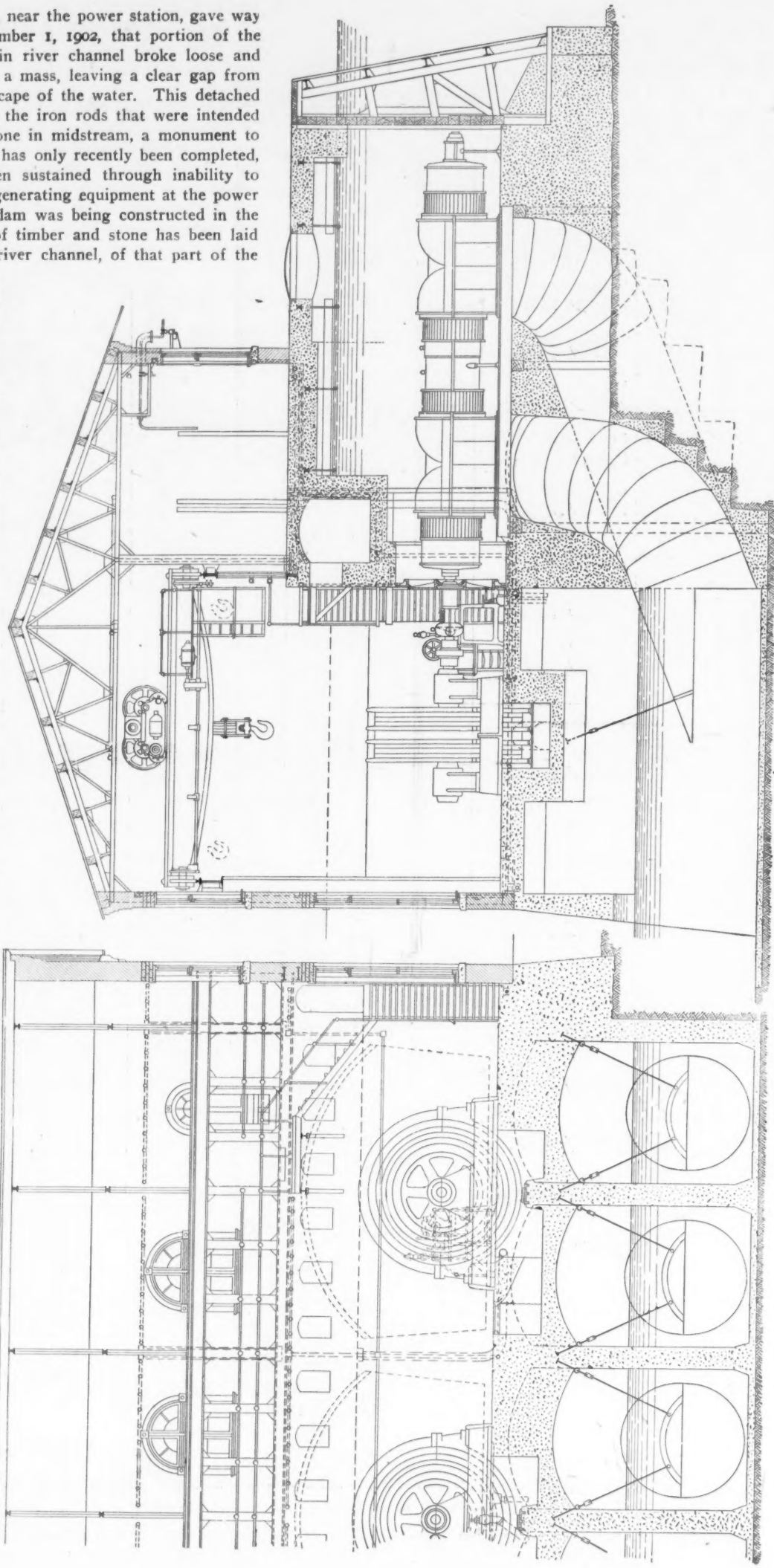


FIG. 7.—SECTIONAL ELEVATION THROUGH WHEEL HOUSE AND POWER HOUSE.

city, each, but only eight of these generators have thus far been installed. To drive twelve generators in the way stated, each having a horizontal shaft geared to six vertical wheels, it was thought desirable to arrange the generators in three groups, each group being two generators wide and two long. Between these three groups of generators and beyond each group extend their horizontal shafts, so that there are two long, parallel rows of these shafts with six shafts in each row. To house generating equipments aranged in this way requires a long, narrow building, and the power station at Lachine Rapids is accordingly 1,000 feet long and 50 feet wide in the main part. At the three points where the groups of generators are located, the width of the power station is increased to about 70 feet, and the switchboard is in one of these wider portions. Each of the alternators now installed at this power station is of General Electric make with internal revolving magnets, and is rated at 750 kw and 5,000 volts, three-phase. The original frequency of 60 cycles per second has been increased to 53 cycles by a small raise of speed, so that the Lachine plant may operate in multiple on the distribution lines in Montreal with the plant at Chambly, where the original frequency of 66 cycles per second was lowered to 63 for a like reason.

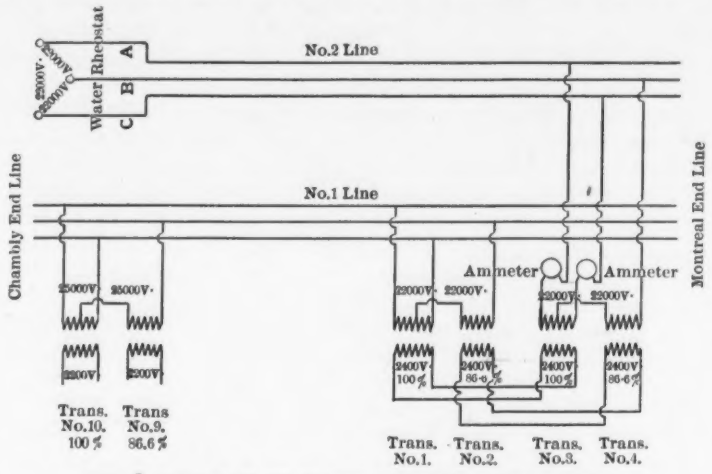


FIG. 8.—DIAGRAM OF WATER RHEOSTAT CONNECTIONS.

As may be seen from the above, the total capacity of alternators now at the Lachine station is 6,000 kw. Four exciting dynamos are provided for these alternators, each being rated at 75 kw and 90 to 175 volts. Each exciter is driven at a normal speed of 660 r.p.m. by a belt from a separate water wheel. The wide range of voltage just named was provided for at each exciter because the available head of water at the Lachine power house is subject to much variation, causing changes in the speeds of both the alternators and exciters, and these changes must be compensated for by different currents and degrees of saturation in the alternator magnets, in order to maintain a constant alternating voltage. With a view to these changes of saturation in the magnets of alternators, these magnets were so designed that at full speed and voltage their degree of saturation is below the usual figure.

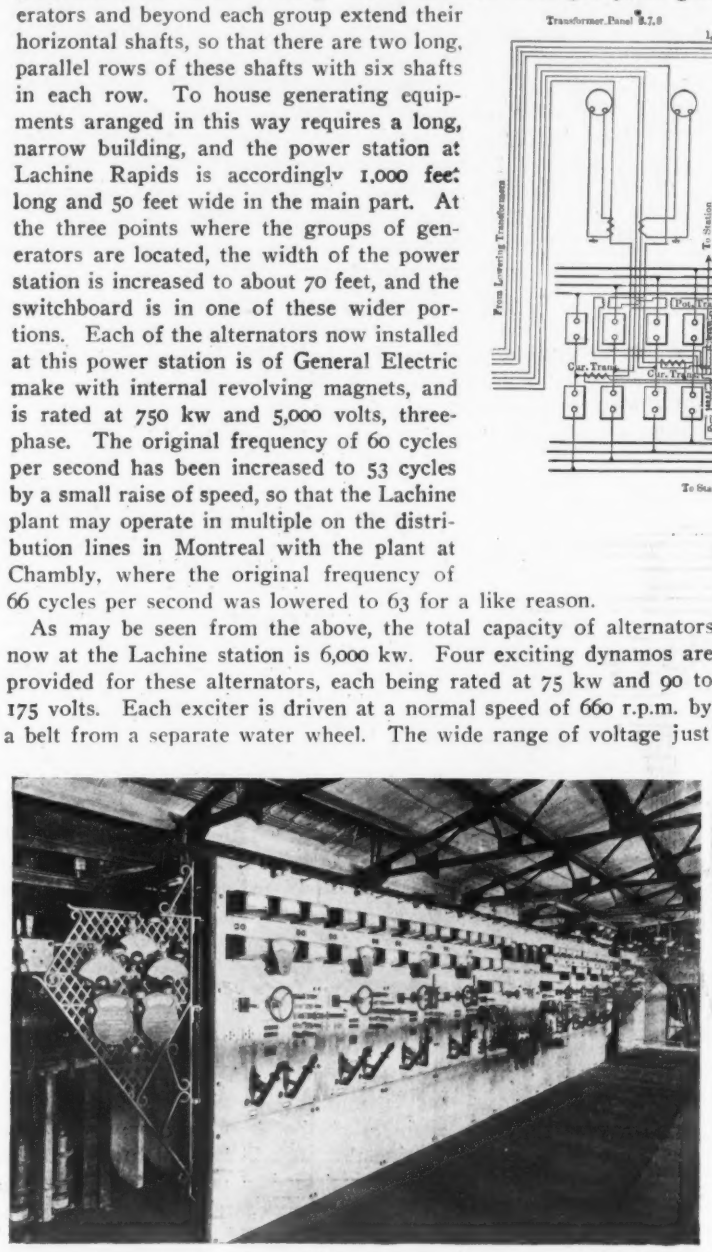


FIG. 9.—CHAMBLY SWITCHBOARD.

The distance from the Lachine power house to the sub-stations in Montreal is so short that no step-up transformers are employed to raise the voltage of 5,000 developed in the armature coils of the alternators, and energy at this pressure is delivered to overhead lines for transmission to the McCord Street and the central sub-stations. These lines are carried in large part by steel poles with wooden cross arms. In this case the steel poles are built up of structural shapes, and are erected from 100 to 125 ft. apart, as might be done with wooden poles.

Up to 1902 the transmission line between the water power plant at Chambly and the central sub-station in Montreal was operated at 12,000 volts, and in this line there were 12,000 ft. of cable in pipes and conduits under ground and under water. This 12,000 ft. of cable was all of the single-conductor type, each conductor consisting of 37 strands equal to 00 copper wire. In each cable the stranded conductor was insulated with vulcanized rubber compound to a thickness of ¼ in., and then with two layers of rubber tape. Outside of the tape came a seamless covering of lead 3/32 in. thick. This cable was installed in January, 1898, and continued in use until some time in 1902.

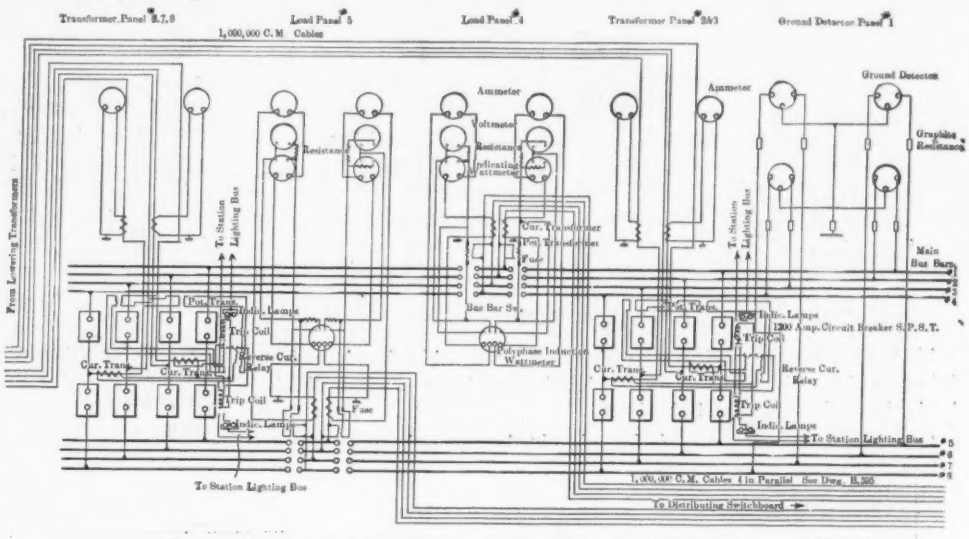


FIG. 10.—LOW-TENSION TRANSFORMER SWITCHBOARD.

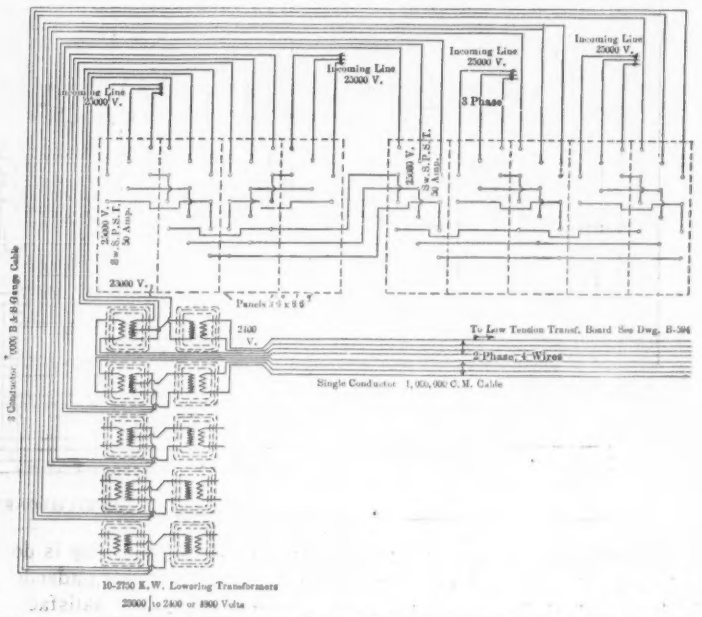

Incoming Line 23000 V.
3 Phase
2300 V. 3w-S.P.S.T. 50 Amp.
2300 V. 3w-S.P.S.T. 50 Amp.
Panels 3 & 4
2300 V.
To Low Tension Transf. Board See Dwg. B-594
3 Phase, 4 Wires
Single Conductor 1,000,000 C.M. Cable
3 Conductor 1000 B.&S. Gauge Cable
10-2750 K.W. Lowering Transformers
23000 to 2300 or 1800 Volts

FIG. 11.—INCOMING LINE AND TRANSFORMER PRIMARY SELECTOR 23,000-VOLT BOARD.

The lead sheath of the cable contained 3 per cent. of tin, but had no outside coating or covering. A part of this cable was laid in creosoted wooden boxes, and a part in iron pipes. During the entire

four years that this cable was in use carrying a current of 12,000 volts, two-phase, there was no failure. Furthermore, during 1½ years of this time, the only method used to protect the cable from lightning discharges was that of barbed wires strung on the poles that carried the overhead conductors, and connected to a ground wire at each pole. As the territory between Chambly and Montreal is

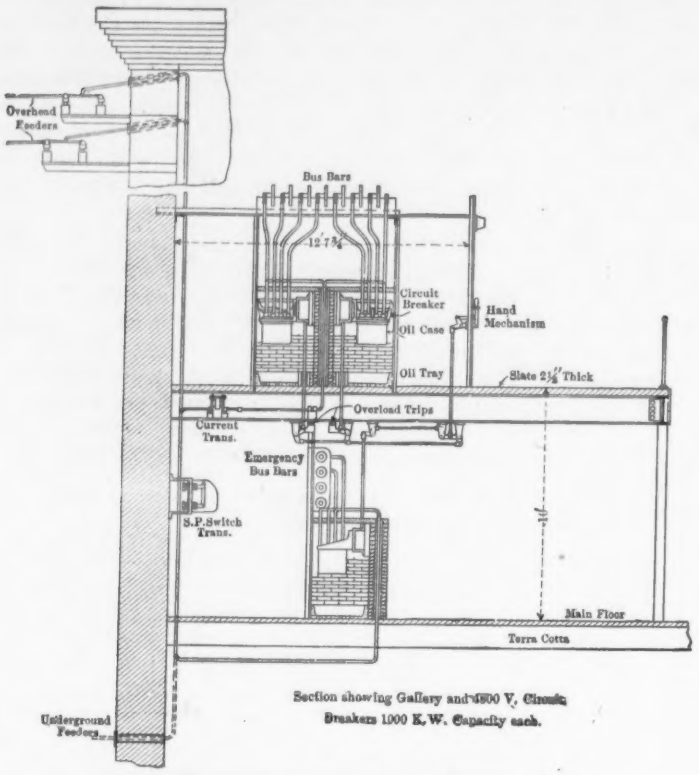


FIG. 12.—SECTION THROUGH DISTRIBUTING BOARD.

subject to frequent and severe thunderstorms, this freedom from injury to the cables is of interest as bearing on the protection afforded by barbed wires against lightning.

On the 25,000-volt transmission circuits between the power house

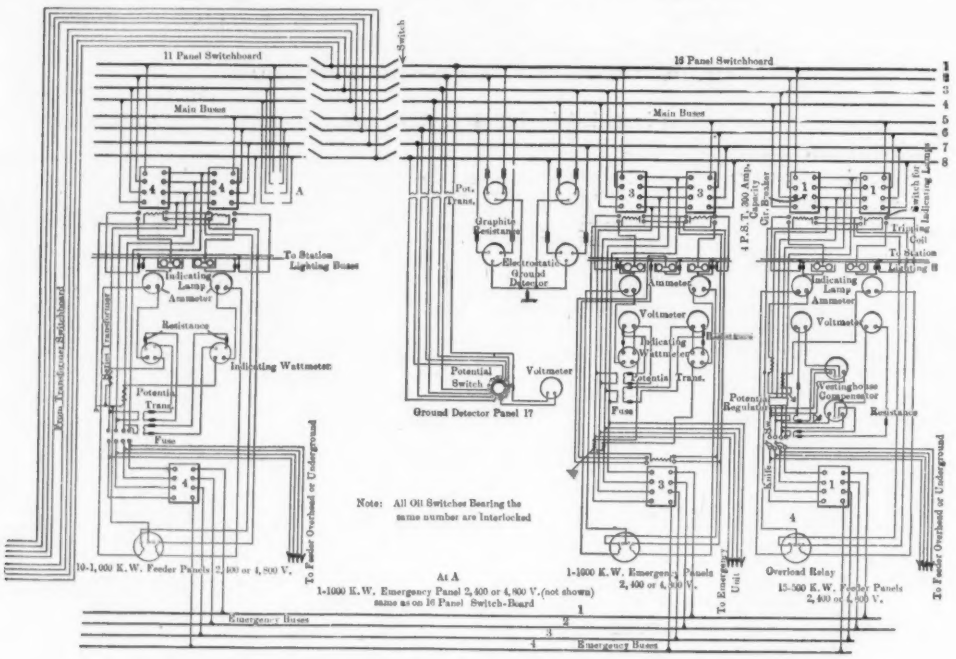


FIG. 13.—DISTRIBUTING FEEDER SWITCHBOARD.

at Chambly and the central sub-station in Montreal switching is done only when there is no load. All switching of transformers under load is done with their low-tension coils, and this has given satisfactory results. No fuses are employed in these high-tension lines. Operation with a grounded neutral to protect transformers has led to no trouble with the transmission circuits themselves or with nearby telephone wires. In spite of the high voltage on this line the insulators have given no trouble by puncturing, and no arcs have started between the wires. Telephone service with its wires on the same poles with the power circuits is satisfactory, but has been found more subject to noise in wet than in dry weather, and with heavy than with light current on the line. No one has been hurt by electric shock while using a telephone. Repairs on the transmission circuits have been made at all times of day and in all kinds of weather without injury to workmen, but during such repairs no energy is sent over the wires on the poles where work is being done. The transmission line is patrolled three times a week.

For the purpose of testing the new transformers at the Chambly plant and the sub-station, and also the two 25,000-volt transmission lines, a rather novel plan was adopted. At Chambly, near the power house, three 40-ft. cedar poles were fastened together in the form of a triangle, and from each of the three corners a plate of iron 2½ in. wide, ⅛ in. thick, and several feet long was suspended in running water, so that the plates were about 50 ft. apart. The three conductors of one transmission circuit were then connected respectively to these three iron plates. At the central sub-station in Montreal the other ends of these same conductors were connected to the high-tension coils of a group of transformers. The other transmission circuit was connected to the 25,000-volt coils of a group of transformers at the Chambly power house, and to the high-tension coils of a group of transformers at the central sub-station. The 2,400-volt coils of the two groups of transformers at the sub-station were also connected. In this way energy delivered to the group of transformers at Chambly was transmitted to the sub-station, through the two groups of transformers there, and then back over the other line to the metal plates in the water at Chambly.

The foregoing facts concerning the largest electric water power system in the world have been collected through the kind co-operation of Mr. H. H. Henshaw, secretary and treasurer; Mr. P. G. Gossler, superintendent and engineer, and various employees of the Montreal Light, Heat & Power Company.

Radium Notes From England.

A special cable dispatch to the New York *Sun* of December 19 says: Discoveries are now coming thick and fast. One which unfortunately has escaped is puzzling a well known electrical investigator. He was experimenting a few weeks ago with a large vacuum tube containing, as he supposed, vapor mercury, such as he used in an electric light. He connected the battery and obtained a brilliant white light. He disconnected the battery, and to his astonishment the tube continued to shine as bright as ever. The wonderful light continued for ten days, the experimenter all the time trying to solve the mystery. Then the whole connection was accidentally broken, and all attempts thus far to reproduce it have failed.

The scientific world seems almost dumfounded at Prof. William Ramsay's discovery that the elements are, after all, transmutable. It is felt that what has been regarded as one of the foundations of science has been destroyed. Prof. Oliver Lodge now launches the following stupendous theory: "There are those who have surmised that matter is, after all, only the weapon and vehicle of mind. The way it interprets itself to our consciousness through the sense of the organs gives no clue to its nature. A motion and alteration of the configuration of the molecules of our brain are believed to accompany every act of thought. It will be, at any rate, a suggestive analogy if a material process of an essentially similar sort is found to be occurring throughout what we know as the inorganic world—the world of dead matter—and we should begin to ask, Does all this motion correspond to some universal thought or mental activity likewise?" Not the least interesting thing about the new work in radium has been this zeal exhibited in making the discovery apply to all the old and new theories in metaphysics as well as physics.

Application of Single-Phase Alternating Current for Traction and Railway Service.

BY B. G. LAMME.

THE present direct-current railway system has limitations in voltage, speed control, etc., which have long been recognized by the electrical profession. Many systems have been devised with more or less success—generally with less—in order to overcome these limitations, so that the possible field for the direct-current systems could be extended. It has also been recognized by some of those familiar with the problem that a single-phase alternating current motor having the characteristics of a direct-current series motor would at once furnish a means of attaining many results now impossible with the direct-current system. Such a motor obtained, then the voltage limitation can at once be removed, as the transforming properties of alternating current can be brought into use. Also economical operation at any desired speed can readily be obtained through the same property of alternating current. Furthermore, the use of single-phase permits a single overhead wire where track return is used, thus retaining a most valuable feature of the direct-current system. It is thus evident that a motor of this character will permit the retention of most of the present advantageous features of the direct-current system, and also enables the use of other features not permissible without great complication and expense with the present direct-current system.

There has been perfected only one class of single-phase motors which possess the characteristics of the direct-current railway motor, and this one class of motors very closely resembles the direct-current machine in the general features. These motors may all be given the general name of commutator type single-phase motors, as all of them have commutators on the armature or rotating member, and the armature is provided with a direct-current type of winding. Some variations from the usual types of armature windings have been proposed, but the various direct-current types have proven most successful.

All these commutator types of motors, which have the variable speed characteristics suitable for railway service, may be broadly classified as belonging to the series type. By this we mean that the field or exciting current is in series with the armature circuit, either directly or through transformer action, either in the motor itself or outside the motor. The series type of motor can be subdivided into two classes, viz., the straight series motor, in which the current in the field wholly or partly passes through the armature, or vice versa; and those in which the field or armature forms a secondary circuit, the primary of which can be either part of the field structure of the motor, or may be outside of the motor. All these motors—whether of the straight series or of the transformer type—have the property that the field magnetism varies with the load, although not necessarily in direct proportion. Hereafter we will refer to these two types, as the straight series and the transformer types of motors. All these motors are related to a greater or less extent in their characteristics, and in many instances one type can be readily changed to the other type. In fact, by closing a single switch, we have changed a straight series motor into the transformer type with the armature closed on itself, forming a secondary circuit, with a change in performance apparently due only to the amount of material in the magnetic circuit being insufficient for the best performance as a transformer type.

In these commutator type single-phase motors, the two most important elements, besides the speed characteristics, are the efficiency and the power factor. The efficiency of such motors will usually be less than that of a direct-current railway motor of the same output. The losses in one of these alternating-current motors can be considered as made up of the following elements:

First.—Iron loss due to reversals of magnetism in armature and field at the frequency of the supply circuit.

Second.—Armature iron loss due to variations in magnetism dependant upon rotation of the armature.

Third.—Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element.

Fourth.—Losses in field windings.

Fifth.—Loss in armature windings.

Sixth.—Brush losses.

Seventh.—Friction and windage.

Comparing these losses item by item with those of a direct-current motor, we see at once that certain losses will necessarily be greater than in the direct-current motor.

First.—Iron loss due to the frequency of the supply circuit and induction in the primary element. No such loss exists in a direct-current motor, as the machine is excited by continuous current. This loss in the alternating-current motor will not be a relatively large per cent, unless the motor is worked at a very high induction, or unless the construction of the magnetic circuit is such as will allow eddy current losses. It is at once evident that the field magnetic circuit must be laminated as completely as the armature circuit, and that there are no local circuits permissible in the field structure. It is also evident that a field structure of a straight series motor will, in general, have lower losses than of the transformer type, where the field itself forms part of the transformer, as in this latter case the total induction in the field structure will generally be greater than in the series type.

Second.—Armature iron loss due to variations in magnetism dependant upon rotation of the armature. There will be a loss in the armature due to the alternating magnetism from the primary or field circuit. This can be charged against the field loss or primary loss, as maintained above. In addition to this loss, there is a loss due to the rotation of the armature in the field. This will be dependent upon speed of rotation, inductions in the core, teeth, etc., and in general will practically average the same as that of a direct-current motor of same capacity.

Third.—Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element. This is a loss which appears to some extent in the field pole face of direct-current machines, due to the bunching of the lines from armature teeth. This loss is relatively small on direct-current machines, if the poles are properly laminated and if the air gap is relatively large compared with the width of the armature slots. This loss in direct-current motors is included in the armature iron loss measurements, due to the methods generally used for determining iron loss on such motors. This loss will appear in the field surface or face of the alternating motor, and may be considerably greater than in the direct current, if a smaller air gap is used than in direct-current practice. By air gap we mean clearance from iron to iron.

If the field structure is of the slotted type, the slots being of such form as to give bunched lines, then there will also be a loss in the armature surface due to the bunching of these lines. It should be noted that the frequency of the secondary currents set up by the bunched lines from armature or field teeth is generally very high compared with the frequency of the supply circuit, or of that due to the rotation of the armature in the field. We believe that in general the loss due to the bunched lines will not be much greater in the alternating-current single-phase motor than in the direct-current, except where very small air gaps are used on the alternating-current motor.

Fourth.—Loss in field windings. This loss is very similar to that in direct-current machines, as the amount of copper in the field windings will generally be no greater than on direct-current motors of same capacity, and may even be considerably less. The straight series motor will generally have a lower copper loss than the transformer types where the field structure is used as the primary of the transformer.

Fifth.—Loss in armature windings. The loss in the armature windings will be very similar to that in a direct-current machine, as far as the working current is concerned. In addition to the working current, there may be secondary currents in the armature turns short circuited by the brushes, which still further increase the armature loss. The resultant armature loss may, therefore, be somewhat greater than on a corresponding direct-current machine, unless the normal resistance of the armature winding is reduced below that of a corresponding direct-current machine. In practice the loss in the armature winding is made practically equal to that of the direct-current machine, in order to avoid increased heating.

Sixth.—Brush losses. The brush losses due to the reversal of current in the single-phase alternating-current motors are generally somewhat greater than in a direct-current motor. Such motors are usually wound for a comparatively low voltage on the armature, and thus greater brush capacity is required than in direct-current practice. The brush losses are thus increased, due to the greater number of brushes, and in addition there may be local currents in the short-circuited coils, which may produce additional loss in the part of the brush next to the commutator. In practice this loss is

evidently comparatively small, as our experience shows no signs of deterioration in the brushes in regular service. Therefore, the increased brush loss may be considered as principally due to the increased number of brushes required.

The brush loss due to the local currents in the short circuited turns can be reduced considerably by the use of very narrow brushes, a brush spanning one bar or even less. With such a brush there would be short-circuiting only while the brush is bridging two bars, while at intermediate positions there would be no local current. As, in general, the commutators of such motors have a relatively large number of bars, this would mean a very thin brush, possibly less than one-quarter inch in thickness. Such brushes we consider too thin for street car purposes, as any roughness on the commutator would tend to break the brushes. In some of our very early experiences with such motors, we used brushes of one-quarter-inch in thickness, but found they required entirely too much attention, and therefore they were abandoned in favor of brushes of a thickness corresponding to direct-current practice, the later designs of motors permitting the use of such brushes.

Seventh.—Friction and windage. The friction in bearings and the windage loss in such motors will be very similar to the corresponding losses in direct-current motors, but the brush friction loss will, in general, be somewhat greater, due to the increased brush capacity. Also the large number of commutator bars generally used, tends to increase brush friction to some extent.

It is evident from the above considerations that the various losses in different parts of the single-phase alternating-current motors are either equal to or greater than the losses in the corresponding direct-current motor, although no individual loss, except that due to the reversal of magnetism in the field, may be much greater than in the direct-current motor. The sum total of the slight increases make a difference of from one to five per cent in the efficiency of the motor, this difference being less with larger motors.

The frequency of the supply circuit also has a small effect on the efficiency, although the relation of the losses in the various parts is so involved that no definite figure can be given for this effect.

The losses in the single-phase motor are, to a certain extent, dependent upon the speed at which the motor is operated, with a given current and torque. Assuming a given current, with the motor running at reduced speed, we can note the effect on the losses as follows:

The iron loss due to the frequency of the supply circuit is changed but little. The iron loss due to changes in magnetism in the armature and due to bunching of lines from the teeth are very considerably decreased due to the lower armature speed. The losses in the field and armature windings are practically unchanged, and short-circuit loss in the brushes is not greatly changed. Friction losses in brushes, bearings and windage are all decreased. Therefore, at lower speed, the actual losses in the motor are considerably decreased, but not in proportion to the decrease in output of the motor. Therefore the efficiency decreases slightly with the reduction in speed with a given torque, this efficiency decreasing more rapidly the more nearly the zero speed is approached.

With changes in load, with a given voltage applied the efficiency curve has very much the same shape as the efficiency curve of a direct-current motor, starting low at light load and high speed, and rising to a maximum, and then falling off considerably at very heavy overloads.

After efficiency, the next most important consideration in the performance of such motors is the power factor. This is a feature which does not appear at all in direct-current machines, as the apparent input in such motors represents true energy. In the single-phase railway motor the apparent input in general does not all represent true energy, as a certain component of the input is required to magnetize the motor, and this component represents practically no energy. Also magnetic leakage in the alternating-motor represents a component of the apparent input which is practically wattless.

In a straight series motor a certain magnetizing current is required with a given field winding. The alternating flux through the field winding sets up alternating e.m.f.'s which lag practically 90 degrees behind the energy component of the motor, and the product of the field current by the field voltage thus represents a wattless component of the input of the motor. With increase of load, the field current increases, the induction increases, and therefore the field volts also increase. The wattless component in the field thus varies with the product of two values which are both increasing with the load. The energy supplied to the motor increases approximately in proportion to the current supplied. Therefore, the wattless component in the field increases more rapidly than the energy component. Consequently, if this were the only wattless component in the motor, the power factor would decrease with the increase of load and would be highest at no load. Other wattless components of the input are represented by the cross magnetizing effect of the armature, if such exists, and by the stray field around the windings. As these effects will also increase more rapidly than the energy component, it is therefore evident that the power factor in this type of motor will be highest at no load or at highest speed, and will decrease with the load or speed with a given voltage applied. But if the windings are so proportioned that the wattless component at the rated capacity is relatively small, then a high power factor will be obtained at the rated load and speed. At lighter loads and higher speeds the power factor would be considerably higher. Such a motor can give very high power factors at half loads with correspondingly increased speed. If the motor is operated at lower voltages, then the power factor at a given speed will be very nearly the same as when operated at the same speed at a higher voltage and higher load. Therefore, it is evident that as the speed is reduced, no matter what load is carried, the power factor will be decreased, and at start the power factor will be lowest, as the energy component in this case represents only the losses in the motor. We have tested a 100-hp motor showing 92 per cent power factor at 100 hp, and approximately 98 per cent power factor at one-half load, the voltage being the same in both cases. This question of power factor is largely a question of design, as the magnetizing or exciting compound of the input depends upon the air gap, amount of material, etc. In general, larger air gap means more exciting current.

The magnetic leakage in these motors may be relatively high, or may be comparatively low, this being to a considerable extent a function of the design of the motor, just as in all alternating-current machinery. Generally it is made as low as possible without sacrificing other important features.

If the armature cross induction in a series motor is large, due to excessive armature ampere turn per pole, small air gap, etc., the armature self-induction will be large. Increasing the number of poles will reduce the cross-magnetizing effects, but at the same time will require somewhat smaller air gap, or increased excitation. These two features are, therefore, to a certain extent balanced against each other.

There are various schemes for improving the power factor of the commutator type single-phase motors. These are generally most effective at high speeds, but at start or at very low speeds the improvement is small. In certain designs of both straight series and of the transformer type motors, the magnetizing current can be supplied in whole or in part to the armature circuit instead of the field magnetic circuit by means of brushes on the commutator. At certain speeds, this current can be supplied at a considerably reduced voltage, thus requiring a reduced magnetizing input compared with excitation applied to the field. This excitation can be supplied from the secondary of a series transformer, the primary being in circuit with the primary winding of the armature. The armature excitation will thus vary as the field excitation would normally vary, thus giving the varying field induction, and the series speed characteristics. While this arrangement is effective in improving power factor at certain speeds, yet, as a rule, this gives the least effect at the time when it is most required, viz., at start and at very low speed. This method also requires a second system of brushes on the commutator, thus spacing the brushes on the motor the same distance apart as if double the number of poles were used. For instance, a four-pole motor would have brushes spaced 45 degrees apart instead of 90 degrees. At start there should be practically the same input required for magnetizing, whether the current is supplied to the armature or to the field.

Comparing the straight series with the transformer type of motor, it should be noted that the straight series motor requires less magnetizing current, as the magnetizing current is only supplied to one element of the field. With the transformer type of motor a magnetizing field must be furnished as in the straight series, but there is also a second field set up due to the transformer action, and this also requires a magnetizing current. In other words, it may be considered that there are two magnetic fields set up, approximately 90 degrees apart, each field requiring a certain magnetizing current. These two fields may be considered as forming one resultant field of higher value than either of the components, with a magnetizing

current of higher value than either component. In the series motor the transformer part of the field can be made to practically disappear, only the exciting field remaining; the resultant induction is, therefore, much less than with the transformer type, the field having an approximate average value of 70 per cent of that of the transformer motor, the magnetic circuit being reduced in proportion.

It thus appears that the straight series motor can be made to give a somewhat higher power factor than the transformer type, with the field used as a transformer, and this is obtained with somewhat less weight. This difference in power factor could be compensated for at higher speeds by some means of excitation applied to the armature through the commutator, as indicated above. But for traction service, where the least weight with great compactness of design, is desirable, it appears to us that the straight series motor possesses some advantages. The transformer type of motor with the transformer in the motor itself can be compared with the straight series motor with a separate transformer, if high voltages are to be used on the line. We consider that a number of more compact motors under a car with one separate reducing transformer forms a more suitable combination than a similar number of larger motors, each with its transformer inside itself.

There is one other method of improving the power factor on these motors, and that is by the use of resistance in series with the motors. If the voltage on the motors is controlled by the use of an external rheostat, as in common with direct-current motors, then the power factor with a given torque will be constant and independent of the speed. With a given torque the wattless component of the input of the motor is practically constant independent of the speed, and if the speed is controlled by rheostatic loss, then the energy component will also be practically constant, and the power factor can be made higher at all loads. This may appear to be a good feature to those who have not considered the problem carefully, but it is a fact that a high power factor obtained in this way represents a less desirable condition than the low power factor which would be obtained if the rheostatic method of starting were not used. With a given wattless input from the circuit, the best possible condition as regards effect on the supply system is that represented by the minimum expenditure of energy. A wattless component has a certain effect on the regulation of the system, and any improvement in power factor by increasing the energy component means that much additional effect on the supply system.

It is surprising that so many are so imbued with the idea of high-power factors that they are even willing to obtain it by increasing the losses in the apparatus, thus in reality increasing the load on the system. A high-power factor obtained by rheostatic control would represent no more advantageous condition than the use of resistance in series with an induction motor, when running, to increase its power factor. If a permanent resistance connected be parallel with an inductance motor, it will not increase the power factor of the motor itself, although any measurements of the input to the motor and resistance will show a higher power factor than that of the motor itself; but anyone can readily see the absurdity of this combination, although it does raise the power factor. The use of resistance in series with a motor in order to give higher power factor at starting would represent a similar absurdity, although it would not be as evident on the face of it.

Leaving out the question of power factor, the rheostatic method of starting and controlling the motor will, in certain instances, possess advantages over other methods, especially where the loss in the rheostat will average but a small part of the total power expended over a given period. This method of operation should not necessarily be abandoned in all cases, simply because voltage control can be obtained.

The next point, and one which is of considerable interest to the electrical fraternity at large, is the question of commutation in the commutator type of single-phase alternating-current motor. In the early times in the electrical business it was discovered that there were many things that could not be done with alternating current, and among these was the commutation of alternating current without excessive sparking. This opinion has become so well established that at the present time many engineers are very doubtful of this point. This opinion is based principally upon experiments in commutation of alternating current, mostly made many years ago, and not upon the theory of commutation itself. In many cases it was considered that the alternating current had some mysterious property which caused sparking when attempts were made to commutate it.

If we go back to the early periods we also find many things which could not be done with direct current, but which are done at the present time. I well remember the time—about thirteen years ago—when I was informed by a number of the leading engineers of that time, that it was useless to consider the construction of slotted armatures for railway generators of the then gigantic size of 200 kw. At that time the Westinghouse Company had a railway armature of this size almost completed, and this advice was very discouraging. But as the armature was so nearly ready to test, it was decided to assemble the machine and find out how badly it would work. The result of the tests was such that the Westinghouse Company immediately abandoned the surface wound type of direct-current armature in favor of the slotted type. Other companies probably had similar experiences, for the slotted type is now almost universally used. The above is merely given as an illustration that in direct-current apparatus many early opinions have been abandoned. If one of the 200-hp New York Subway motors had been attempted ten or twelve years ago, conclusions undoubtedly would have been drawn by many engineers, showing the absurdity of attempting to make high class motors of this size.

In the same way advances in the art have lead to a more complete understanding of the underlying principles of commutation among those interested in the design of commutating apparatus, although such knowledge, except in a general form, is limited to a small number of engineers. Very few of all those who handle modern direct-current generators or motors, really know why their machines commutate so much better than some of much older designs which were apparently built on the same lines.

Motor designers with a wide experience in the problem of commutation are now awakening to the fact that commutation of alternating current does not furnish a set of new and mysterious phenomena, but that the laws which apply to direct-current commutation also apply to alternating-current commutation, and that the problem is one of degree principally. If a continuous current of X amperes have its direction reversed in a coil without sparking as the coil passes under the brush, then there should be no difficulty in reversing this current if it varies periodically from X amperes to zero and up to X amperes again. The trouble is that when opinions on commutation of alternating current were originally formed it was not known how to commutate the current of X amperes.

The principal difficulty in commutation of alternating-current motors has been the presence of local secondary currents in the coils short-circuited by the brushes, such currents being due to pulsating or alternating magnetism through the short-circuited coils. Various arrangements have been tested at different times for lessening the effect of these secondary currents. Such motors are usually built with a comparatively large number of commutator bars, with a very small number of armature turns per bar, to lessen the effect in the short-circuited coil. Very narrow brushes have been tried in order that the period of short circuit may be lessened, and two or more parallel windings forming the so-called "Sandwich" type have been tried. These windings lie side by side on the core, but are practically independent of each other and connect to alternate commutator bars, or to every third bar, etc., dependent upon whether two or three parallel sets are used. With two of such parallel windings on a core a commutator brush of a width slightly less than one bar could be so placed that it would never short-circuit a coil of either winding. In this case the brush passes from one winding to the next, and breaks connection with the first winding before passing to the next bar of the first winding. With this arrangement the short-circuiting of the coils would be diminished, but the type of winding is one which we do not consider satisfactory for railway motors. We consider that this is simply transforming the trouble due to the short-circuited coil to another trouble which would in the end be just as serious, viz., the tendency of such windings to produce blackening and pitting of the commutator bars. Such an arrangement would require very thin brushes if but two parallel windings were used, while with three parallel windings the brush could have a thickness corresponding to two commutator bars.

A number of other devices have been tested at various times by different experimenters, but these are attempts to cure an existing difficulty rather than to lessen or eliminate the cause of the difficulty.

Within the past year or two there has been a great awakening to the possibilities of this problem, with the consequence that there is now a world-wide appreciation of the field of operation for commutator types of single-phase motors which will accomplish results not hitherto attainable. Single-phase motors having good commutating properties are now on the market in this country for the com-

mercial frequency of 25 cycles per second. Higher frequency motors could probably be built with reasonably good results, but as 25 cycles has become a commercial frequency in this country, it is probable that this will become the standard for traction service for single-phase motors.

A single-phase motor having series characteristics having been obtained, it is at once evident that it opens up various methods of control hitherto not utilized in railway service. Having the motor which can be controlled in speed by variations in the voltage supplied to it, then voltage control can at once be obtained due to well-known properties of alternating-current transformers. Such methods of control are dependent upon the use of alternating current, and have not been applied in railway apparatus heretofore, because there was no suitable motor on the market.

Many forms of apparatus for varying the voltage on alternating current circuits have been known and used, and most of these devices permit voltage variations with comparatively small loss in power. Therefore, with an alternating motor with the series characteristics, it is at once evident that we can obtain a traction system in which the power expended is practically proportional to the work done, and therefore the least power will be consumed at starting and at low speeds. This is an ideal condition for railway service, but has not been permissible with the direct-current system, except by great complication.

There are a number of ways in which the various single-phase commutator type of motors can be controlled in speed. With the straight series type, the voltage applied to the terminals can be varied, the field windings can be varied, commutated, etc., or the relative values of armature and field strength may be varied. Also with certain designs of motor exciting brushes may be placed on the commutator, as we have indicated before, and the voltage applied to these brushes may be varied. All these methods may be used also with the transformer types of motors.

Also by shifting the polarity of the fields to one side or the other of the normal position, the speed can be affected to a greater or less degree, and similar results can be obtained by shifting the armature brushes. The latter method we do not consider a suitable one for traction motors. Also series-parallel control can be used, if desired, just as on direct-current motors, and rheostatic control can also be used. These two methods have practically the same effect on economy as found with direct-current motors with these methods of control.

Single-phase motors of all types, in common with polyphase induction motors, have one feature which is not shared by direct-current motors, viz., there is an active voltage between the field turns. The alternating magnetic flux through the field of the alternating motor generates an e.m.f. in the field windings, just as in the case of an alternating-current transformer. In the direct-current motor the only voltage in the field coils is that represented by the current flowing against the resistance of the windings. Therefore, in a direct-current motor a short-circuit can occur between one or more turns of the field coil without disastrous effects on the motor. Those who have had a wider experience in the operation of electric railways and are familiar with the extremely high temperatures momentarily obtained under certain conditions, will appreciate the importance of this feature of the direct-current motors. If direct-current motors were so designed that short circuit between two turns due to overheating or other conditions would disable the motor so that it could not be operated, then it would be necessary to very considerably increase the dimensions of such apparatus in order to get emergency capacity. It will at once be appreciated that the alternating-current motor, with an active voltage between field turns, must be designed to stand heavy overloads without danger of short circuits between field turns. Therefore, either these motors must be designed with more margin of temperature than the direct-current practice, or the windings used must be such as will permit of more insulation between turns than is used in direct current practice. If such motors are wound for voltages corresponding to direct-current railway practice, then there is greater danger from short circuits in the field than with direct-current motors, and if the motors are wound for comparatively high voltages —say, 3,000 volts, for instance—then the danger from this source is very considerably increased, for in a 3,000-volt motor a large number of comparatively small wires must be used in each coil, and these must be well insulated from each other, and the entire winding must be well insulated from ground. Experience with alternating-current high-voltage stationary motors has shown that such motors are not nearly as safe as those wound for 200 or 400 volts, and we believe that for motors under a car, subjected to the extreme variations of traction service, the danger from short circuits and grounds will be very much greater than in the case of stationary motors. It such traction motors are wound for low voltages, say 200 volts, approximately, then heavy conductors and but a very small number of turns will be necessary on the field, and each conductor can be separately insulated both from other conductors and the ground.

Therefore, the alternating current permits the use of low-voltage motors, with the consequent advantageous construction of field coils where the conditions of operation in direct-current practice prevent the use of any lower voltage than that supplied by the line. Troubles from oil and dirt, such as frequently occur with direct-current motors, will become of great importance in alternating-current railway motors wound for very high voltages. We believe that, except for very special cases, it will be found safer to step down the voltage on the car by a transformer, thus supplying the motors with low voltage from the secondary circuit rather than to wind each motor so that it becomes a transformer subjected directly to the high voltage of the system. In cross-country work, where high voltage would preferably be used, the step-down transformer method also furnishes additional protection from lightning, as it is well known that it is easier to insulate one transformer from lightning than to insulate two or four motors. The question of safety to the passengers and apparatus in the car also should be considered in this matter.

A large number of estimates have been made comparing the general performance, cost, etc., of equipping roads with single-phase alternating-current motors instead of direct-current motors, supplied from rotary converter sub-stations. In all these cases the advantage has appeared decidedly in favor of single-phase, except in a small number of cases where some small limiting condition was placed upon the alternating-current system. If the starts are very infrequent and the running periods long, then the gain in efficiency by elimination of the rheostatic losses at start may be more than compensated for by the slightly lower efficiency of the motors themselves. Where such conditions apply, generally high trolley voltage will be used, and there will be enough gain in efficiency in the transmission and distributing to more than balance the loss in the equipment. Furthermore, the elimination of the rotary converters will furnish a still further gain in efficiency. In estimates made up to the present time, we have, in practically all cases found higher total efficiency for the single-phase railway than for the direct-current railway with sub-stations. In cross-country work the gain in the transmission and distributing system and the rotary converters compensate for other losses. In city work where starts are very frequent and low speeds necessary at times, the gain by elimination of the rheostatic control has appeared as a very important item in the efficiency.

It thus appears that, while suburban work was once thought to be the most important field for the single-phase railway, it has now become evident that city work, where traffic is very congested in parts of the system, will prove to be one of the best fields for this system. Of course, it is recognized that for heavy railroad service, where all kinds of speeds should be obtained economically, the single-phase railway system will undoubtedly show to great advantage compared with any known direct-current system. But as considerable time will be required to equip any railroad service, it is probable that the single-phase railway system will be well tried out before there is a good opportunity to give it a thorough trial for heavy work. There is no difficulty in designing single-phase motors for sizes up to 300 hp or larger, and of sufficiently small dimensions to be used with a single reduction gear on locomotives. There is also no difficulty in designing regulating devices for controlling the power of such motors. For example, a 600-kw induction regulator manufactured by the General Electric Company has been in commercial operation at Niagara Falls for many years, and a regulator of this capacity would be sufficient to control a 2,400 hp locomotive. The induction regulator furnishes an ideal method for locomotive control, as the voltage supplied to the motors can be varied over a wide range without making or breaking the circuit.

In conclusion, we would say that the subject of the commutator type of motor is now being thoroughly studied by engineers in all the principal manufacturing companies in the world, and there is no longer any question that such motors can be built successfully for commercial service. When it is once shown that such motors are feasible and that, therefore, a new field of development is opened, there is immediately a willingness on the part of most of the manufacturing concerns to undertake the perfection of such apparatus. What is needed in any line of development is a promise of success, and it may be taken as true that success will then be obtained.

Telephone Transmitters.—II.

BY ARTHUR V. ABBOTT, C. E.

THE description of typical instruments of each of the preceding forms will now be given.

First, Single-Contact Instruments.—The first microphone was a carbon pencil leaning against a pair of carbon blocks. To make a microphonic transmitter it was essential to put this apparatus in commercial shape. This resulted in the famous Blake transmitter, invented by Francis F. Blake, of Boston, which for many years was almost solely employed by the American Bell Telephone Company, and which to-day may be seen in some localities, although the more modern solid back has almost displaced it. The Blake instrument is shown in half-tone in Fig. 5, while a section and an elevation of the transmitter mechanism is shown in Fig. 6. The Blake transmitter consisted of a small black walnut box 5 9/16 in. wide x 6 11/16 in. high and 2 13/16 in. deep, the dimensions being over all. The object of the box was to provide a receptacle for the induction coil and to protect the working parts of the transmitter from injury. The mechanism was placed inside the door of the box, the center of which was, on the outside, hollowed to a trumpet-shaped cavity, containing a hole in the center through which the sound waves could impinge upon the diaphragm. Fig. 6 gives a section through the mechanism and the elevation of the inside of the door. A heavy brass ring, *c*, was screwed to the door, which formed the foundation of the transmitter. A diaphragm of sheet iron 2⅝ in. in diameter and .013 in. thick, whose edges were covered with a rubber strap, was placed in the center of this ring, and retained in place by means of a clamp, *g*, and a rubber-tipped damping spring, *f*. Upon the foundation ring two lugs, *h* and *i*, were cast. From the upper lug, *h*, a U-shaped piece of brass was suspended by means of a german silver spring, *d*. In the lug *i* the adjusting screw, *r*, is inserted, which bears upon the U brass at *n*. The carbon button was ⅜ in. in diameter and ⅛ in. in thickness. It was made of the purest and most homogeneous carbon, free from grit and with a surface as highly polished as possible. The button was spun into a case, *c*, which may be of any convenient size sufficient to adequately hold the button, and the whole affair suspended from the upper end of the U brass by means of a small steel spring .01 of an inch thick and 9/64 in. wide, over which is slipped a rubber band to prevent

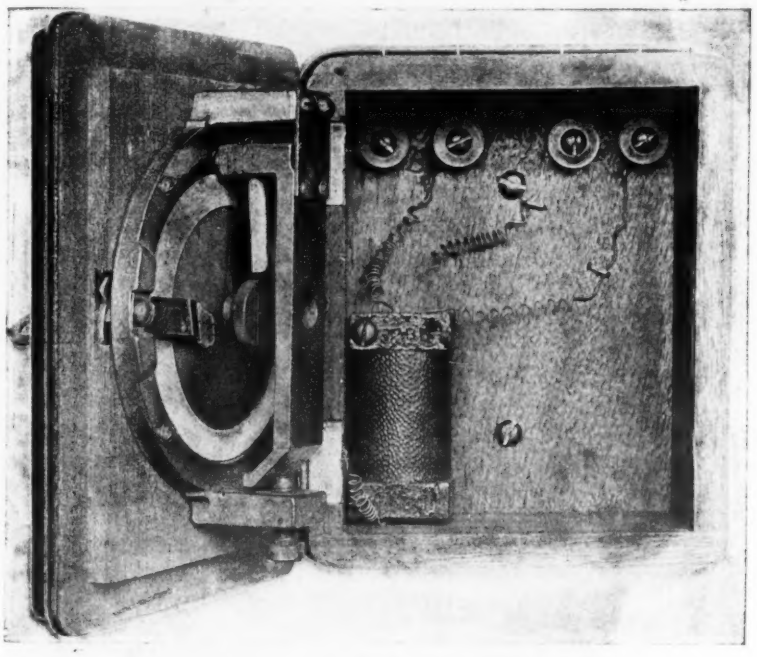


FIG. 5.—BLAKE TRANSMITTER.

vibrations. A German silver spring, *p*, about .005 in. thick and ⅛ of an inch wide armed at its lower extremity with a minute globule of platinum is placed. This spring was likewise attached to the upper end of the piece, *b*, and so adjusted that it stands in the center of the carbon button, and between the button and the diaphragm. When in proper adjustment the german silver spring should press gently against the carbon so as to follow the latter when it is pulled away for a distance of about ⅛ in. and then leave it. The steel spring is adjusted while speaking into the transmitter by varying the tension with the screw, *r*, until the listener reports the most favorable result. With the Blake transmitter commercial telephony became a possibility, and so far as clearness and fineness of articulation is concerned few, even of the most modern instruments, equal the Blake, and it is doubtful if any sensibly excel it. But the Blake, even under the most favorable circumstances, is so deficient in volume that even upon short lines, those whose hearing

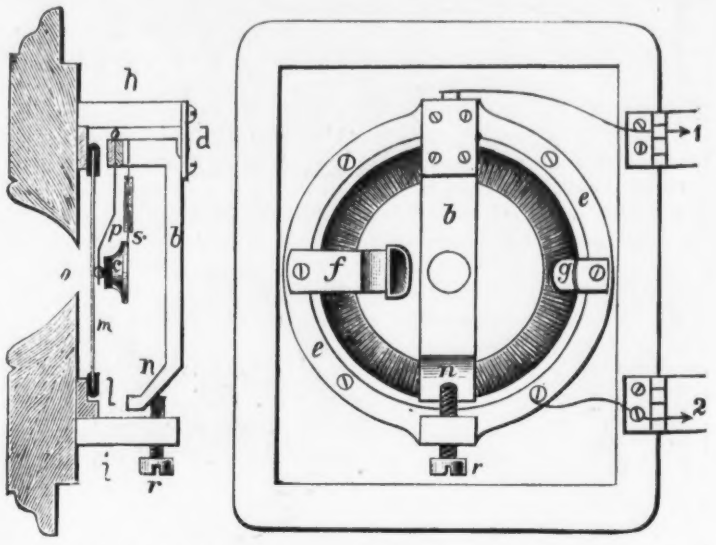


FIG. 6.—BLAKE TRANSMITTER, SECTION AND ELEVATION.

is in the slightest below normal, find the use of the telephone an impossibility, and upon long lines it is impractical for any.

Second, The Series-Contact Transmitter.—This type of instrument is represented in Fig. 7, one form of the many instruments proposed, which should embrace several microphonic contacts in series with each other. A diaphragm, *D*, was furnished with a plunger, *M*, behind which a tube, *T*, was placed that contained a number of carbon bullets. The rest of the construction of this model is self-evident from the illustration. Transmitters of this description have not been markedly successful, and from our present conceptions of the operation of the microphone contact, one is likely

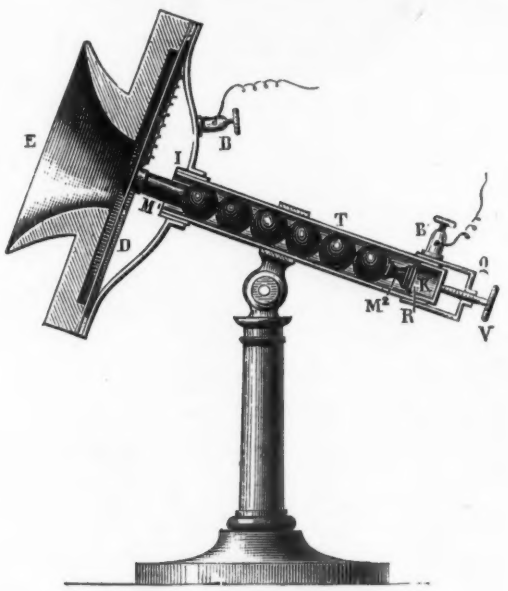


FIG. 7.—SERIES CONTACT TRANSMITTER.

to wonder at the expenditure of so much time and energy upon series contacts, for it is very obvious that if the operation of the transmitter is to be that of a valve it is either necessary to make one valve large enough to acommodate the maximum desired current or to put a number of valves in *multiple*, as it is manifestly impossible that one valve in series with another of the same capacity can transmit a greater volume than a single one is able to pass.

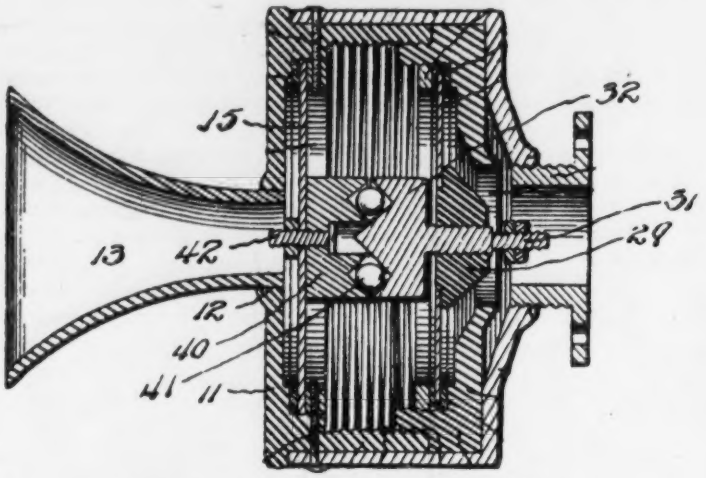


FIG. 8.—MULTIPLE-CONTACT TRANSMITTER.

FIG. 13.—SOLID-BACK WITH CASE REMOVED (SIDE VIEW).

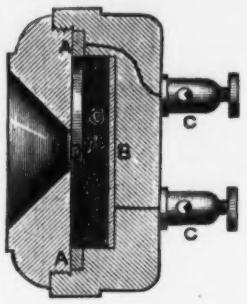


FIG. 9.—HUNNING TRANSMITTER.

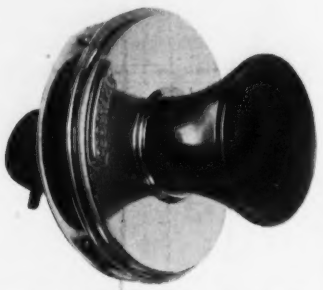


FIG. 11.—WHITE SOLID-BACK TRANSMITTER HEAD.

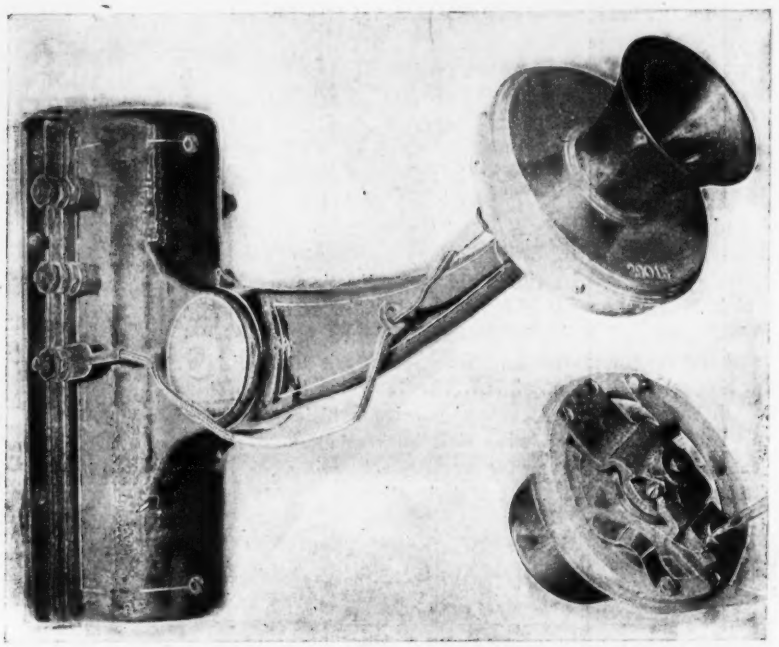


FIG. 10.—SOLID-BACK TRANSMITTER.

FIG. 12.—SOLID-BACK WITH CASE REMOVED.

FIG. 14.—SOLID-BACK PARTLY DISSECTED.

FIG. 15.—SOLID-BACK COMPLETELY DISSECTED.

Third, The Multiple-Contact Transmitter.—It was soon perceived that it was hopeless to expect great improvements from the series-contact instrument, and designers then turned attention to arranging contacts in multiple in order to obtain a greater volume of current without interfering with the delicacy of control. A typical instrument on the multiple-contact plan is shown in Fig. 8, and all instruments of this class are similar in general construction. There is a case, 11, provided with a mouthpiece, 13, behind which a diaphragm, 15, is situated. In the center of this diaphragm a carbon button, 40, is secured by means of a screw, 42, through the center of the diaphragm. This carbon button has a V-shaped groove cut in the face opposite the diaphragm. Upon the rear of the case, enclosing the apparatus, a second carbon button, 32, is attached which carries a similar V-shaped groove, the two buttons being adjusted with reference to each other, so that these two grooves are concentric. When the instrument is assembled a series of carbon balls, 41, about as big as No. 8 shot, are placed in the rectangular cavity formed by the V-shaped grooves. By this means quite a number of microphonic contacts in parallel may be obtained. The angles of the groove are such that the carbon balls by gravity always tend to assume the lowest position and normally lie in contact with the two buttons; thus any vibration of the diaphragm will cause a variation in pressure between many and probably all of the contacts thus provided. Multiple-contact instruments have been much more successful than the series-contact type, and at present several models are manufactured and are fairly successful.

Fourth, Multiple-Series Transmitters or Granular Instruments.—To carry the multiple-contact idea to the extreme is to provide a transmitter with a multitude of such contacts. The first, and most famous, instrument of this type is the Hunning transmitter, illustrated in Fig. 9. It was an exceedingly simple device, consisting of a case, *B*, containing a hollow receptacle, in front of which a diaphragm, *D*, was placed. This diaphragm was in the first model made of platinum, while the rear of the case was lined with a similar material, and the intervening space filled with powdered carbon, or in other words the carbon bullets of Fig. 8 were made as small as possible and as numerous as possible. This, so-called, granular instrument, has formed the foundation of all of the modern types, and has, to all intents and purposes, practically displaced every other design.

The Hunning transmitter was at once recognized as much more powerful than any of its predecessors. Unfortunately, it was afflicted with a disease, toward the remedy of which all subsequent inventors have directed their efforts with as yet but partial success. This difficulty is known as "packing" and seems to be due to the gradual settlement of the carbon granules under the inevitable jarring and vibration to which the instrument is subjected, into a compact mass at the bottom of the receptacle which holds them, and under these circumstances the contact between the granules is no longer affected by the slight change of pressure produced by the diaphragm and the instrument ceases to talk.

In some systematic investigations upon the relation between pressure and transmission, conducted at the Massachusetts Institute of Technology it was shown that the operation of a Blake transmitter depended partly upon the pressure which the springs holding the carbon button and platinum globule exerted, and partly upon the inertia of the button itself. In order to eliminate one of these factors Mr. Anthony C. White carried on an extended investigation, which resulted in the production of the *"White transmitter"*; usually known as the *"Solid Back,"* from the fact that the rear electrode, instead of being mounted upon a spring, as in the case of the Blake instrument, was made as rigid and substantial as possible. The complete White Solid Back is shown assembled in Fig. 10. Fig. 11 shows the transmitter head. In Figs. 12 and 13 the rear of the case is removed. In Figs. 14 and 15 the instrument is entirely dissected, while Fig. 16 is a full-sized sectional drawing.

There are four essential parts: A base plate, *E*, Fig. 16: This is a solid, substantial brass plate, 3¼ in. over all, in the center of which a ⅞-in. hole is cast and threaded for the reception of a funnel-shaped rubber mouthpiece. The inside of this brass plate is faced off for the reception of the diaphragm, *D*. This is now usually made of aluminum 2½ in. in diameter and .022 in. in thickness. Experience has shown that the aluminum is likely to corrode under the moisture deposited from the breath, and it is now customary to thoroughly varnish the diaphragm as a protection. The diaphragm is surrounded with a soft rubber band of sufficient width, so that it laps around the edge of the diaphragm ¼ in. This forms a cushion and affords an even bearing between the diaphragm and the face place. A piece of brass 1 in. wide and ⅛ to 3/16 in. in thickness, termed the "bridge," *M*, is substantially bolted across the front of the face plate. This metal piece is bent in the form of a U in order to afford room for the capsule which contains the granular carbon. As is shown in Figs. 14 and 15, this capsule consists of a brass cup ¾ in. in diameter and 5/16 in. deep. Upon the rear of this cup a stud projects which passes through the bridge and is secured therein by a nut, a set-screw and lock-nut. Upon the bottom of this brass cup the rear electrode is placed. This consists of a carbon disc as hard as possible, and carefully and highly polished, 21/32 in. in diameter and 1/16 in. in thickness. Over the front of this brass cup a mica diaphragm, *O*, is placed and secured by a circular ring of brass, which is screwed down on top of the diaphragm, clamping it to the front edge of the cup. This diaphragm is 27/32 in. in diameter and as thin as the mica can be readily split. The front electrode consists of a piece of carbon similar in all respects to the rear electrode. Both carbons are electroplated and soldered to their respective holders. The support for the front carbon consists in a disc-shaped piece of brass having a threaded stem, *P*. This passes through the mica diaphragm and by means of a nut, *L'*, the electrode and the mica diaphragm are clamped firmly together. Then the stem is inserted in a hole in the diaphragm and secured by means of a second nut, *R*. Two damping springs, *F*, made spring steel 11/32 in. wide, 1/100 in. thick, 1 7/16 in. long, bent to be at right angles when not in place, and tipped with rubber, are employed to check vibrations of the diaphragm, and secured by two screws to the face plate, as indicated in Figs. 12 and 13. One pole of the battery is connected to the framework, *B*, of the transmitter and current reaches the rear electrode; passing through the granular carbon it reaches the front electrode, thence to the nut, *L'*, and thence by a fine wire soldered thereto, to an insulated terminal, *S*, to which the other battery pole is attached (Fig. 12). The essential features of the White Solid Back are thus seen to be: A substantial support for the rear electrode; a capsule to contain the granular carbon between carbon electrodes, closed in such a manner as to be air-tight and moisture-proof, and to permit the freest possible motion of the front electrode; a vibrating diaphragm rigidly attached to the front electrode, so as to convey to it its motion in the freest manner; finally, the whole apparatus covered by a thin cap of spun brass, which is turned to fit against a shoulder in the face plate and secured thereto by means of four screws.

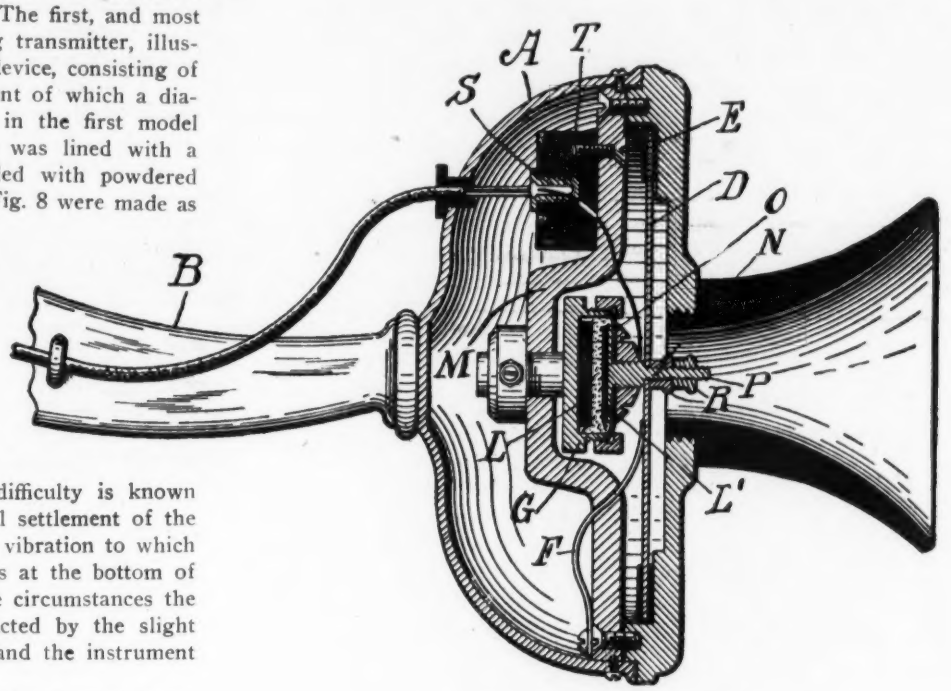


FIG. 16.—SECTION OF SOLID-BACK (FULL SIZE).

The Evolution of the Electric Railway Motor.

The New York Electrical Society had another large and successful meeting this season, on December 16, when Mr. S. T. Dodd, electrical engineer of the Stanley Electric & Manufacturing Company, who has long been connected with the railway art, contributed an admirable address on "The Evolution of the Electric Railway Motor." The lecture was freely accompanied by lantern slides, some of which had never before been made public. An abstract of the lecture follows. President Carty was in the chair, and in addition to his pithy comments, interesting remarks were made by Messrs. C. O. Mailloux and R. T. Lozier.

The early investigators of the electric railway problem—Edison, Field and others—made the mistake of attacking it from the locomotive standpoint, and consequently their efforts contributed little or nothing to the soluion of the problem. The first electric street car to be driven by a motor placed under the car floor was put into operation in 1884 in Cleveland, Ohio, by the Bentley-Knight Company. A Brush arc machine was used as generator, and a machine of the same type was used as motor, the latter being connected to the car wheels by a wire rope drive. The Brush type of machine later proved itself eminently unfitted for this service, but, at that period, it was the only successful high-voltage machine, and it was believed that in this type lay the promise of the coming long-distance transmission of power. This combination of Brush machines worked reasonably satisfactorily when there was but one car on the line, but when other cars were added the generator behaved very badly, as was inevitable, since the attempt was being made to run the motors in parallel from a constant-current machine. Troubles were also experienced with the wire rope drive and with the conduit. The experiments on this road made it evident that further developments must be along one of two directions: Either the current must be supplied to the cars at a constant potential or the motors along the line must be operated in series. The Bentley-Knight Company followed the former of these alternatives in their later work.

In '85 and '86, various experiments were made by Messrs. Daft, Sprague, Van Depoele and Short. Mr. Short attempted to develop a series railway system, and built a road in Denver which was soon abandoned. To Mr. Short should be given the credit of seeing that for motors of the normal speed of that date, double-reduction spur gearing should be used. By '87 or '88, both the Bentley-Knight and the Sprague companies had developed bi-polar, series-wound motors especially for railway service, and it was about this time also that public attention began to be attracted to the work.

The years '88 and '89 were very eventful. The Sprague and Edison interests consolidated, the Bentley-Knight interests were acquired by the Thomson-Houston Company, and there appeared on the market a Westinghouse double-reduction motor and a Short double-reduction motor. It might be said that the standard railway motor at that date was bi-polar, running at a normal speed of 1,000 to 1,500 r.p.m. It was connected to the axle by double-reduction gearing, it was series-wound and, with the exception of the Short motor, was of the smooth core, drum type. The high speed of these motors was a serious disadvantage. The railway managers complained bitterly of the expense of maintaining gears and pinions. It was seen that the electric railway motor could not be a final and permanent success until some method was found of obviating this difficulty.

The Wenstrom motor of 1890 offered the solution of this difficulty. It was a multi-polar design, with slotted armature, thereby making possible the reduction of motor speed and the change to single reduction. All of the manufacturing companies were quick to appreciate its features, and they appeared on the market soon after with single-reduction motors. The Westinghouse Company then introduced what might be called the first of our modern motors, their No. 3, which, with the minor modifications introduced in their No. 12 and No. 38, remains to-day their standard type. As is apt to happen, two of the companies went to the other extreme of bringing out gearless motors. The objection to the gearless motor of that date was its weight, its rigidity, its inaccessibility and the fact that it was not adaptable to varying speeds.

The "G. E. 800" motor of 1893 was an attempt to make an absolutely enclosed and water-proof motor. With the appearance of the enclosed motor, a new problem was introduced, namely, ventilation, a factor which had previously received but little attention, and which even to-day is not always given the consideration which its importance deserves. In 1894 appeared the "G. E. 1,000," wherein they followed the lead of the Westinghouse No. 3, and had four poles, abandoning the consequent pole design. In 1895 the Walker Company brought out their No. 3, which marked a decided advance in that better provision was made for ventilation than in any previous type of motor. In 1899 the Westinghouse No. 38 introduced laminated poles. In 1896 there was a change in the character of the service demanded of railway equipments brought about by the beginning of interurban roads, and by the extension of city roads into the suburban districts, the new conditions calling for continuous service at moderate loads. In order to meet the new requirements the General Electric Company brought out their No. 52, the feature of which was the ventilated armature which has since become standard. The Walker 15 L, a 100-hp motor, which was built for the Brooklyn Elevated, and the "G. E. No. 51," illustrate the limitation imposed upon motors of the standard type when built in large sizes. This limitation called for a change in motor construction, which was met by such motors as the "G. E. No. 50," and particularly the "G. E. No. 55," built for the Nantasket Beach line and the Metropolitan and Westside Elevateds. The latter had a solid box frame, with waste packed bearings, from which the armature could be removed only by sliding it out through one end. This type has since become popular for very heavy service.

The "S. K. C." type of motor represents a still further development of the principle of motor ventilation. For the first time in a street railway motor, both ends of the armature are left open for the entrance of air into the armature, and there are ducts in the pole pieces and through the frame of the motor which register with the ducts in the armature perpendicular to the shaft. As a result of this usually good ventilation, the all-day load of this motor, Mr. Dodd said, is about 50 per cent of its hour rating (with the same heating) as compared with an all-day capacity of but 35 per cent of the hour rating for other motors of the same grade.

In the "G. E. No. 74" motor is preserved the compactness of the "G. E. No. 5" with the added advantage of increased accessibility of the armature. The "G. E. No. 69" for the New York Subway and the two makes of German motors used upon the Berlin-Zossen line are the most modern types of motors for heavy service, and in each of them it should be noted increased attention is being paid to ventilation. As is well-known, the Berlin-Zossen motors are alternating current, and mark a reversion to the gearless type discarded ten years ago.

Thus our present type of motor had grown from the stationary motor of twenty years ago. It is now a series motor, a characteristic which it inherited from the Brush motor used by the Bentley-Knight people in 1884. It is hinged upon the axle and geared to it by spur gearing, for which we are indebted to Messrs. Sprague and Short in 1886; it is a multi-polar motor, with slotted armature, which is derived from the Wenstrom motor of 1890; it has concentric fields, with salient poles, projecting inwardly from the surrounding case and the armature is series connected, so that one pair of brushes suffice for a multi-polar motor, characteristics which are derived from the Westinghouse No. 3 of 1891. It has machine-wound coils and a barrel armature, which are due to a development through the Westinghouse No. 3 ,the G. E. 800, and the Walker. It has laminated fields, which were introduced by the Westinghouse No. 38 in 1895; it has a ventilated armature for which they were indebted to the G. E. No. 52 of 1896.

At the present time, increased attention is being paid to disposing of the heated air from the interior of the motor and the ventilation of the motor for long ime service. This means that the motors of the future will have reduced weight of electrical parts, magnetic iron and conductors, and more attention will be paid to the bearings, gears and other mechanical parts. Considering the changes in motor design during the last twenty years, which he had sketched, Mr. Dodd remarked in conclusion that it would be idle to assert that they had yet reached a permanent standard type or that new motors will not be produced from year to year as new improvements are suggested and new problems confront them for solution.

Electrical Iron Smelting.

Advices from the Dominion state that the Canadian Government is looking into the subject of the electrical smelting of iron, and is sending a commissioner to Europe to study up the subject. Canada has many available iron ore deposits in the vicinity of large water powers, where coal may happen to be difficult of supply.

Electrical Equipment of the Edison Portland Cement Company.

That any plant designed under the direction of Thomas A. Edison should present unusual features is naturally taken for granted, and the presumption does not fail in the case of the great cement works which have recently been erected after his designs in the Portland cement region of Northern New Jersey. The apparatus employed is almost all absolutely new in cement making, but nevertheless is not untried for the class of work to be performed, having been adapted from similar machinery perfected by Mr. Edison at his iron ore plant at Edison, N. J. The plant is specially designed for outputs on a huge scale. The rock crushers daily handle rock in sizes as large as five tons; fine grinding on the basis of a 200-mesh sieve is done in a grinding roll which has a record of 280 barrels an hour; an air blast process of separating the fine from the coarse ground material is employed and the raw materials are burned in rotary kilns 150 ft. long and 9 ft. in diameter. An unusual arrangement of buildings exists, the particular feature of which is the subdivision of the colony into groups, each devoted to a distinct part in the process of manufacture and all more or less independent of one another. The main power for some of the groups, both electrical and mechanical, is supplied by a steam engine centrally located with respect to the group, but the entire conveying system throughout the works as well as some of the machinery, is driven by about

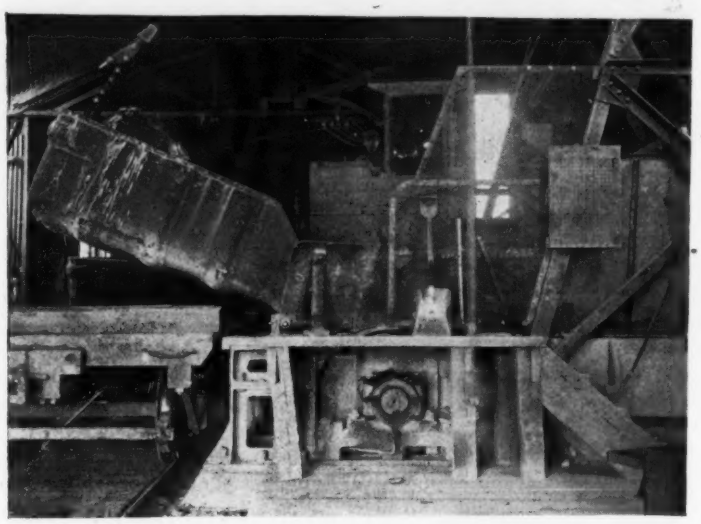


FIG. 1.—SKIP UNLOADING DEVICE.

125 electric motors furnished with current from a central station. All of the motors were designed and built at the works of the Edison Manufacturing Company, at Orange, N. J. The electrical work is of much interest, owing to the care taken to protect the motors from dust and to the plan of controlling them to a large extent from the generating room, both of which features will be described further on.

The property of the Edison Portland Cement Company comprises about 600 acres in the valley of Pohatcong, two miles in extent and of varying width. At one end are located the works proper, on the Delaware, Lackawanna & Western Railroad, at New Village Station, near Stewartsville, N. J., and at the other, a matter of 1½ miles distant, is the quarry. A standard-gauge railway, owned by the company, connects the quarry to the plant. This comprises six groups of buildings besides the usual adjuncts, as, for example, machine shop, oil house, laboratory and office. The first group comprises the crushing plant; the second the weighing plant, where the proper mixtures of the raw materials are made; the third, the raw material grinding plant; the fourth the burning or calcining plant; the fifth the clinker grinding and cement storage plant, and the sixth the coal pulverizing plant. The two grinding and the one crushing plant take the most power and each has its own steam engine.

A feature of each group is the provision of storage capacity, so that each department can be run without absolute dependence on its neighbor; but all are interconnected by an extensive system of conveyors. The latter is arranged so that if materials are furnished faster than the apparatus can care for, excess of the material is carried automatically back to the proper storehouse. The first two groups have been designed for the full capacity of the works, 10,000 barrels per day, while the rest have largely been planned for 5,000 barrels present capacity. Space is available for practically an indefinite number of cement stock houses.

On reaching the works from the quarry the train of flat cars is hauled under a storage shed, which is an open steel frame structure with roof to protect the raw material from rain while awaiting its turn to the crushing mill. The crushing mill comprises four sets of rolls placed one above the other so that the passage of the material through them is downward by gravity; and the rock from the quarry has thus to be hauled to a point above the highest pair of crushing rolls. Accordingly, there is an incline, some 260 ft. long, extending to a floor about 50 ft. above ground and the cars are hauled up this three at a time by means of an electric hoist. The storage shed is slightly above the bottom of the incline, and under the control of a brakeman the three cars are run down to the incline by gravity. They are then attached to the end of the hoisting cable and hauled to the crushing floor, the end of the hoisting cable having a dolly car by which connections are made. The operator of the hoisting motor stands in a pulpit above the floor and by means of the large rheostat controller brings each skip in succession opposite the mouth of the hopper above the main crushing roll. The skips are placed sideways on flat cars, and the operator then starts another motor which automatically catches the handle at the far side of the skip, lifts it into position, when the rock falls into the hopper, returns the skip to the car, the hook releasing its hold from the handle, and brings the next car into position. The skip-lifting device is counterbalanced by a cube of concrete hung from the cable to which the hook is attached. The empty cars are then allowed to descend the incline and, at the proper moment the brakeman releases his three cars and they take a siding alongside the storage shed until a train is made up and the empty cars are returned to the quarry. At the same time the brakeman that has descended before him is now on his way with his train of three loaded cars.

The first pair of crushing rolls, which constitute one of the noteworthy features of the plant, are each 5 ft. in diameter and 5 ft. long and the moving parts weigh approximately 25 tons each. They take any size of stone weighing 5 tons or less, and are driven at 200 r.p.m., which corresponds to a peripheral speed of over 3,000 ft. per minute. Under the giant rolls, which are the design of Mr. Edison, there is a hopper having a capacity of 10 tons, and material is fed from it to three sets of 36-in. rolls below. These reduce the material to ¼-in. and less. The first have a fly-wheel to assist them in crushing large pieces that pass through the giants, and both the first and the second rolls are set rigidly at fixed distances between faces, while the third are held together by a set of coil springs. This plant is driven by belting through a friction brake from a 500-hp vertical cross-compound Allis engine operated condensing. The engine also drives a 100-kw General Electric generator which supplies the current for the motors in this department, an arrangement which exists in the case of the two other large power engines, in furtherance of the plan to render the departments as independent as possible. The result is that the central electric station is comparatively small to what it would otherwise be. The crusher house has a capacity of 3,000 tons per day of 20 hours, allowing for 16 hours of actual running and 4 hours of stoppages.

From the last set of rolls the crushed material falls on a belt-conveyor 24 in. wide, which carries it upward to the top of the rock dryer house. Here the material falls by gravity over screens composed of ½-in. mesh screen plates. The spalls that are rejected by the screens are delivered to another belt-conveyor, which takes them back to a point above the third set of 36-in. rolls in the crusher house. They are recrushed and returned to the dryer house. Material passing the screens falls by gravity to the dryer, which consists of a cast-iron box, 8 x 8 ft. in plan and 40 ft. high, filled with baffle plates. The top set of plates is moved slightly by a shaker mechanism to avoid clogging. As the material falls through the dryer, it comes in contact with hot gases from a group of furnaces below, the passage of the gases being accelerated by means of an 80-in. Buffalo exhauster, which delivers into a dust separator. The separator is large enough that, by the reduction of the speed, most of the dust is collected and delivered to a conveyor, which also takes the discharge from the dryer, lifting it to a transfer tower, by which it is carried into the rock stock house. The furnaces are ordinarily run with the doors above the fire pit open so that there is always a large enough volume of air, with the idea of inducing a generous

flow of comparatively warm air rather than a lesser volume of gas at a very high temperature. The furnaces are operated also with a blower connected to the ash pits, to increase the draft. The exhauster is driven by a 50-hp electric motor and is in normal operation designed to pass 20,000 cu. ft. of air per minute. The dryer has a capacity of 3,000 tons per day, corresponding to 10,000 barrels of finished product.

At the transfer tower, as the material is dumped from the one conveyor to the conveyor running into the stock house, there is an automatic sampler. This comprises essentially a plate hinged like a damper, with the hinge horizontal and at the lower edge, and thrust periodically into the material as it falls from the one conveyor to the other. It catches one pound per minute.

The rock stock house is a building partly under ground and partly above, and has a storage capacity of 10,500 tons, divided into seven bins. A feature in connection with the design of the stock house is the auxiliary means provided for drying in the event that the material should remain or become wet after it is delivered from the dryer proper. This means comprises a furnace at one end of the building and of a large fan, 15 ft. in diameter, at the other end. Whenever excess moisture is present in the stored rock the fan serves to create a suction of warm air through the building from the furnaces at the other end. This fan, which is direct-connected to a 15-hp motor, is designed to pass 60,000 cufl ft. of air per minute. The second general division or group of buildings comprises the weighing and mixing house and a small rock stock house. The raw material grinding plant comprises the grinding house and adjacent engine house, the separating or blower house and the ground material store house. The raw material is fed to a set of fine grinding rolls which were designed by Mr. Edison. They are practically the same as those used by him in his ore-separating work. The rolls are 28 in. in diameter and have an 8-in. crushing face. One roll is driven from the main shaft and two others are driven from it by friction. The pressure between the rolls is obtained by means of an endless cable passing over sheaves on the ends of the two friction-driven rolls. Tension is secured in the cable by means of an air cylinder in which the pressure can be regulated at will. A remarkable fact in connection with the rolls is that the plates on them, formed into regular corrugations, last three weeks, and the life of the wire rope is about 150 hours. When the repairs made at this frequency are charged against the capacity of the rolls, however, the cost is but a fraction of a cent per ton. The grinding rolls are arranged to receive an extra roll and additional sets are to be added to bring them up to a producing capacity of 5,000 barrels of cement per day. When the house is increased in size and other rolls are installed, the producing

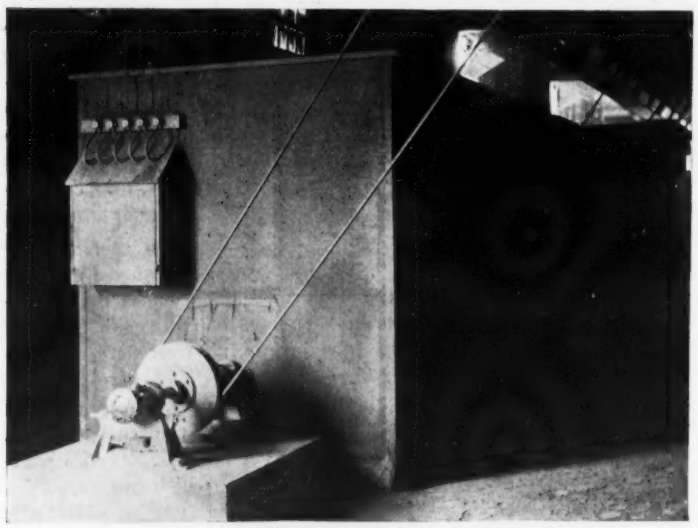


FIG. 2.—GUNNY CHAMBER FOR MOTOR PROTECTION.

capacity will be 10,000 barrels per day. The engine is of the same type as that in the crushing plant, but it is larger, having a rating of 750 hp. It also drives a 100-kw generator for the motors in this department.

The separating apparatus is another of the striking features of the works. This is located in the blower house, so called, a relatively large building, in which the finely-ground rock is distributed to the discharge ducts of some sixteen blowers and the fine material separated from the coarser by the action of the air blast assisted by baffle plates. The 10 per cent. of the material that fails to pass the 200-mesh screen is that caught by the baffles, and it is returned by conveyors to the fine grinding rolls. At present there is space for eight more blowers, and, by increasing the building along the dotted lines, the capacity of the blower house can be increased to the full 10,000 barrels.

A belt-conveyor, in this case 36 in. wide, serves to carry the discharge from the grinding rolls to a longitudinal belt-conveyor in the top of the upper part of the blower house. This, by means of

FIG. 3.—CABLE AND MAIN TUNNEL.

two S-dumps, feeds a number of chutes, one to the discharge duct from each blower. In this duct the material falls through a set of baffle plates, while the current of air is passing through it, and the air carries the dust into a large settling chamber beyond, where the dust settles at the bottom on account of the reduced velocity of the air. This chamber in each case has walls of coarse duck through which any inequalities of air pressure may be compensated without losing the ground rock, but one of the secrets of the success of this method of separating is that the air for the suction side of the fan is taken from the top of the chamber. The blower thus sets up an internal circulation and its work is mainly maintaining that circulation. Each blower, which is of Mr. Edison's design, has a blast wheel of 5 ft. and they are driven in groups by motors on the main floor of the blower house. The blowers and duck-enclosed chambers are arranged in two rows, and on each side underneath the settling chambers is a scraper conveyor which collects the separated fines. This scraper delivers to a belt-conveyor which in turn carries the fine material into the so-called chalk stock house. This has a capacity of 1,000 tons. The separated coarse material is collected under each side of baffle plates, is delivered to a belt-conveyor in the lower part of the blower house and by means of another conveyor returned to the fine grinding rolls.

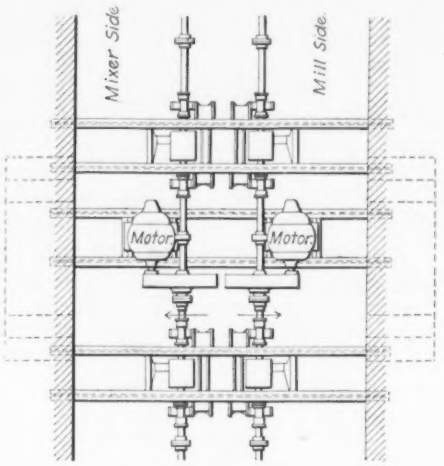
In the stock house a swinging type of screw conveyor is employed, known about the works as "Cæsar's wife." This consists of a truss bridge a few feet above the floor carrying an 18-in. screw conveyor held close to the floor. The bridge is pivoted at the discharge end of the conveyor, and the outer end is swung in the arc of a circle by means of a stationary rack on which it is moved by means of a pinion. At the pivoted end the bridge carries its own electric motor and operator, who is enclosed like the motors throughout the plant, as will be explained, in a house of gunny sacking.

The kiln plant comprises the so-called roaster house, a clinker crusher and a clinker stock house. Adjacent to it is the boiler house of the works and the air compressor house. The kilns have the striking proportions of 9 ft. diameter and 150 ft. length. There are at present two of them in a building 52 x 220 ft., but ground space is available for a roaster house six times as large, providing for twelve kilns. Raw ground material is fed by a scraper conveyor into two bins, one above the charging end of each kiln, and from the bottom of each bin the material is fed, as desired, by means of a 6-in. screw. Each of these is driven by an independent electric

motor, so that the speed can be regulated to suit the conditions.

The crusher clinker is taken from the stock house by chutes leading to a belt-conveyor in a tunnel underneath it and in its transit the proper amount of sulphate of lime is added; it is then taken by a belt-conveyor to an elevator and thus fed into the feed rolls above the clinker grinders. The grinding rolls here are counterparts of those in the raw material grinding plant and a 750-hp engine is also required to drive it, the engine being in an adjacent building and also connected to an electric generator for the local motors.

The cement stock house has a capacity of 100,000 barrels and there is provision for additional stock houses. Between each pile in the cement house is a transverse conveyor having two 16-in. screws. This conveyor can travel from one end of the building to the other and discharges upon a longitudinal 12-in. screw conveyor at one side of the stock house. The operator of this conveyor takes his station in an enclosure at one corner of the building at the end of the 12-in. screw and can tell that "Big Cæsar" is in operation by the delivery of cement by the 12-in. conveyor. At this end the 12-in. conveyor discharges upon a belt-conveyor leading into the packing house. Here there are at present four bagging and two barreling



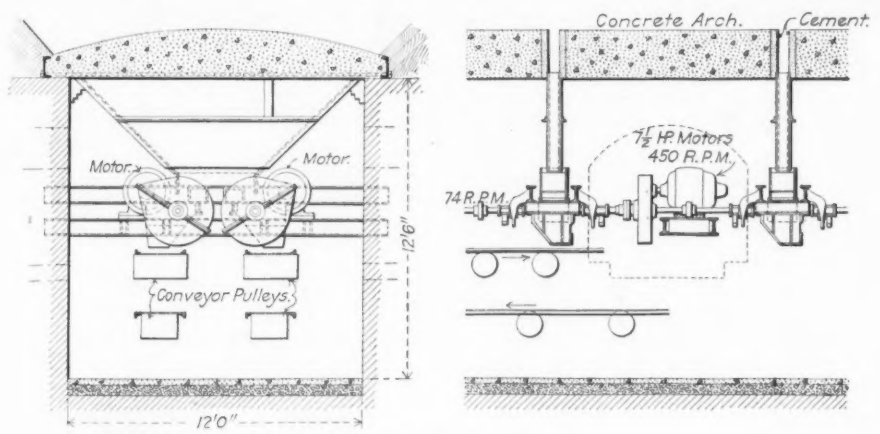


FIG. 4.—SECTION AND PLAN, CONVEYOR TUNNEL.

machines of the usual type. A railroad siding is alongside, where the cars are loaded from the platform.

The belt-conveyors so extensively installed about the plant are all of a canvas type and were manufactured by the Gandy Belting Company. The belts are run at speeds of 500 ft. per minute and the inclination, where the travel is an upward one, is generally about 14°. A point of detail that might be mentioned regarding them is an enclosed type of lubricator for the bearings of the idlers, the lubricating medium being oil and not requiring attention more than once in two or three months.

The boiler plant at present consists of three Climax boilers, each having a rating of 500 hp on a 30-pound evaporation basis. Steam is conducted from the boiler plant through piping in an underground tunnel about 1,700 ft. long, which extends the length of the works and also contains the horizontal conveyors, the water and air piping and electric conduits. A feature in its construction is the provision of a roof above ground between buildings with glass skylights to admit daylight. The three main steam engines are located along the line of the tunnel. The injection water pipe for the condensers is also carried in the tunnel, but the discharge from the condensers, which are of the independent jet type of Allis make, furnished with each engine, is conducted in an open concrete trench outside of the buildings leading to a sewer, which finally discharges into a sump and is pumped back to the reservoir.

Besides the engine for the coal plant there are two horizontal engines in the engine house adjoining the grinding plant for the raw materials. These engines are Armington & Sims tandem-compound machines and each drives by belt a 200-kw General Electric direct-current generator. These units supply the current for all the motors throughout the works not connected with the generators driven by the three Allis engines, already mentioned.

A feature of control of the electric motors is that they are ordinarily all started from the central station. Three wires run to every motor, two being the regular leads and the third a conductor for separate excitation. In starting, the motors are all excited from a small generator in the central station; the main generators are then brought up to voltage and, by means of a drum switch, the separate

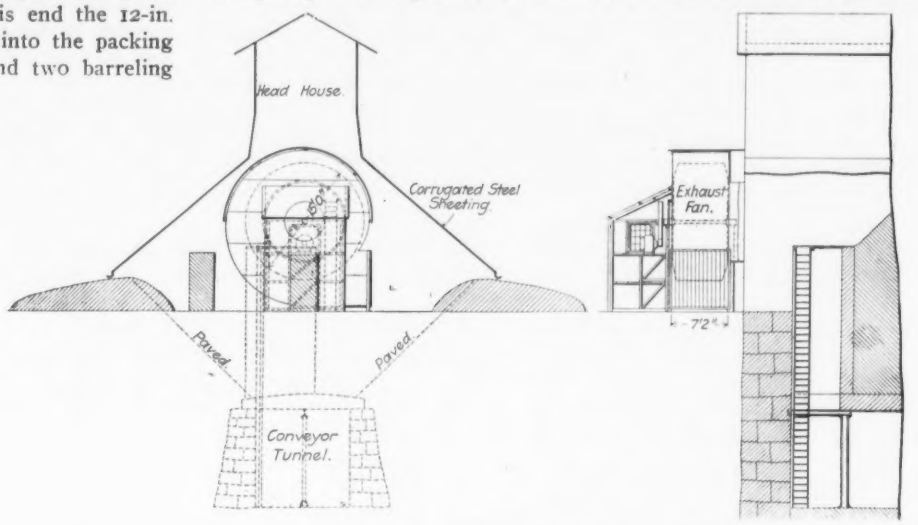


FIG. 5.—SECTIONAL VIEW, CABLE AND CONVEYOR TUNNEL.

exciting wire is cut out and the machines run self-exciting from the generator leads. By starting this way the armature currents in all the motors are dependent on that in the generator, which is being slowly brought up in speed, so that the generators are not subjected to a sudden load, as they otherwise would be if all the motors were started in the regular way. In stopping, a resistance has to be introduced in the main circuit to take care of the collapse of the fields of all the motors and this consists of an extensive bank of incandescent lamps. The lamp bank is connected across the leads, and when the main switch is opened the fields discharge through the lamp bank.

Mention has already been made of the precaution taken to protect the motors from the dust. This is, of course, specially necessary owing to the employment of direct-current motors with their commutators. In the ordinary case the motor is enclosed in a good-sized room, the walls of which are made of gunny sacking. A self-closing door allows access to the room. A small fan of the desk type is set in one of the walls and operates to exhaust air from the room. The action of the fan induces a flow of air through the walls of the enclosure, but they do not allow dust to pass with it. The circulation of air provides for cooling and in every room a thermometer is suspended over the motor and observations are made daily by an inspector. In some places, for example, the blower house or separating plant, where dust is particularly thick, each motor house is provided with an antechamber so arranged that one must close the outer door before he can reach the inner.

The lubricating system for the works is one of the interesting points. For this purpose there is a detached oil house containing the filter, a fresh oil storage tank and a tank for the storage of the filtered oil. The steam engines are, of course, lubricated by the engine operator. Many of the conveyors are self-lubricating, as explained. The cement machinery generally, however, is so located in the midst of dust that ordinary methods of lubrication would be unsatisfactory. On that account an extensive system of oil piping

has been developed, by which all bearings are oiled from the central plant. A small pump in the oil house suffices to set up the required circulation. At the different bearings the supply pipes to them are provided with a short glass sight feeds, so that the attendant at that point can be assured that his machine is getting the proper amount of lubrication. The two oil tanks in the oil house are of practically the same size, of 2,400 gallons capacity. The filtering system was designed by Mr. Edison and first used at the iron ore concentrating plant at Edison, N. J. The filter is divided into three sections, two of which with a capacity of 200 gallons per hour are in use at the same time, leaving the third as an auxiliary.

As a result of the installation of so much new apparatus about which little or nothing could be foreseen regarding possible weak points, a complete system of records of the operation of all departments has been devised. In addition a number of inspectors are employed whose duty it is to make periodical trips about the works and make recommendations for repairs or changes. A summary of the delays in the operation of the works is made at the end of each week and a copy of it is sent to Mr. Edison at his laboratory in Orange, N. J. If there is an indication that a certain piece of apparatus is performing badly, a "trouble inquiry" sheet, so-called, is sent to the plant manager and a special investigation is made. Ordinarily this inquiry sheet passes from the manager to the superintendent, who, in turn, refers it to the department head, and from

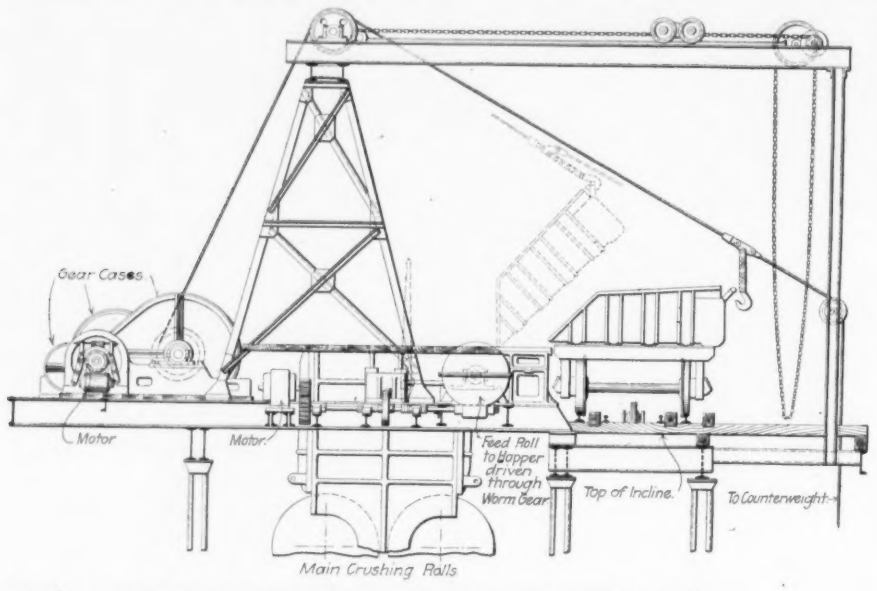


FIG. 6.—ELECTRICAL SKIP UNLOADING MACHINERY IN CRUSHING MILL.

him to the official, employee or inspector responsible. A reply is made on this blank and returned to Mr. Edison. It goes back with the initials of all the officials who have seen it, so that there is an unquestioned record that the trouble had been called to some one's attention.

The officers of the Edison Portland Cement Company are as follows: Mr. William H. Shelmerdine, president; Mr. W. S. Mallory, vice-president; Mr. W. S. Pilling, treasurer; Mr. T. I. Crane, secretary; Mr. Thomas A. Edison, general manager. The general offices are in Philadelphia, while Mr. Edison and Mr. Mallory are located at Orange. Messrs. Goodwelle and Warren are the electrical engineers of the plant. Every day at 4 o'clock a meeting of the heads of departments takes place in the office and the proposed schedule of operations for the following day for the different departments is discussed at that time. The relative independence of the different parts of the works makes it possible, as already stated, to shut down parts of the works temporarily if necessary for any reason.

Telegraphs in Korea.

With regard to the unsettled state of affairs in Korea, a cable dispatch from Seoul says: "Japanese telegraph operators have charge of the line from Seoul to the coast. The possibility of Japanese troops landing to preserve order is discussed, but it would only be done with the consent of the Russian Government." Another dispatch of December 21 from Tokio says: "Sixty military engineers have been dispatched to Korea to replace the civil telegraph operators attached to the Japanese telegraph lines on the peninsula. It is officially asserted that the step taken has no military significance."

Safeguards and Regulations in Operation of Overhead Distributing System.*

BY W. C. L. EGLIN.

The distributing system can be considered as one of the integral portions of a power plant, and it should receive as careful attention as either the steam plant, hydraulic plant, or the electrical plant in the generating station or sub-station. In fact, it would appear that the transmission system has to meet more severe conditions than any other part of the entire plant, so that the safety and reliability of the service depends largely upon the amount of forethought given to the plans and to the selection of material.

When it is considered that an overhead distributing system is subjected to many varied conditions, such as the weather, extreme changes of temperature, extraordinary storms, interference from other lines, interference by building operations, excavations, fires and other casualties, and sometimes a wilful interference by the public (not to overlook the small boy with a stone), it should be readily appreciated that all of these varying conditions must be considered in the construction of the line. There are two divisions of conditions: First, the mechanical or structural features, and, secondly, the electrical features.

The first group will include the study of the territory in which the line is to be run, width of streets, kind of buildings, height of buildings; other distributing systems, possibilities of interference with these systems; amount of power to be transmitted, and whether the system consists of a simple power transmission circuit, or one complicated with distributing mains covering the larger part of the territory occupied by the transmission system.

Also to be considered are the weather conditions: windstorms, rainstorms, sleetstorms, snowstorms, lightning-storms and changes in temperature from summer to winter. The method of erecting the conductors so that they can be properly repaired or additions made without endangering the lives of the men engaged in this work must be carefully planned. Unless these various points are all considered in the construction of the lines, no rules or safeguards for their operation will be of material benefit.

The second group includes the electrical requirements: The conductors, the insulating method of support, and the means provided to take care of any undue disturbances due to lightning or other causes on the line, such as lightning arresters, fuses, switches, etc.

SPECIFICATIONS FOR MATERIAL TO BE USED.

All of the material entering into the construction of a transmission system should be ordered under specifications which shall clearly set forth the character of the material to be used and also that all of the material will be inspected before it is used on the work, and that tests will be made of samples of all material furnished. The more general requirements are as follows:

Poles.—Poles should be as short as possible to meet the conditions and preferably made of good, sound chestnut. Southern cedar and pine poles are sometimes used when chestnut is not obtainable. It may also be necessary to use iron poles under certain conditions; but iron poles are to be avoided, principally on acount of danger to linemen and also to the short life of the pole, due to rusting. The pole should be roofed at the top to form a right angle, and gained to form a flat of about 5 inches from the attachment of the cross arms.

All poles, upon which are located devices requiring regular inspection, should be provided with steps in order to facilitate this work. Spacing of the poles should be carefully considered and should not exceed from 40 to 45 yards. End and corner poles should be braced, and at least every tenth pole throughout the line should be guyed with one-quarter-inch or three-eighths-inch stranded galvanized wire. Regular inspections, at least annually, should be made of the condition of the poles, which is most readily determined by examination at the base of the pole. When poles are used as junction

* A paper presented at the December meeting of the American Institute of Electrical Engineers, New York.

poles, that is, when lines are run at right angles and attached to the same pole, special care is necessary. A separate drawing should be made of all such poles, showing the arrangement of the wires—keeping in mind the simplest possible arrangement—as a protection for the men who climb these poles. Switch-boxes, fuses, lightning arresters or transformers should not be attached to such poles, but on the first pole removed from this junction pole. Junction poles can frequently be avoided by the use of two poles making a "Y" connection of the line. By this arrangement the connections are very materially simplified.

Cross Arms.—Cross arms should be spaced at least 24 inches between centres, the top of the first arm being one foot from the top of the pole.

Braces.—Braces should be made of galvanized iron not less than 1¼ inches by 3-16 inch thick, and about 28 inches long.

Pins.—The pins should be made of locust wood well boiled in linseed oil, and are preferable for voltages of 5,000 volts and under. For higher voltages, pins should receive special consideration.

Insulators.—The insulator on the pole line fulfils two functions, viz.: The mechanical support of the line, and the insulation. As these conditions vary over a wide range, they must be considered for each condition. This is especially so for voltages of 10,000 volts and over. The two materials of which insulators are usually made are glass and porcelain. The glass insulator is more uniform in quality of material than the porcelain, so that for lower voltages glass insulators are recommended. For higher voltages, porcelain insulators are preferred for the following reasons: Greater mechanical strength, better insulating qualities, and greater ability to withstand severe weather conditions.

Insulators of high voltages should be made up of a number of insulators cemented together so as to obtain more uniform insulation and to increase the factor of safety from defective manufacture. Before being used, each insulator for high-tension work should be tested at voltages in excess of the operating voltage.

The method of attaching the conductor to the insulator should be carefully considered; first, to see that the wires can be properly fastened to the insulator, and, secondly, to see that the strain is transmitted without a twisting or bending strain in the insulator; the only strain permitted should be in compression.

The method of distributing the wires on the pole lines depends on the number and character of the various circuits to be installed. For all voltages below 6,000 volts, the wire should be brought out of the station through long porcelain tubes, properly supported; the various circuits being grouped together but well spaced, and preferably being distributed in a single, or not more than a double row of wires. This fan effect allows the circuit to be distributed to the poles without any undue bunching, thus making each circuit easily distinguishable.

The top gain of all poles should be left vacant so that guard wires can be placed at any point on the line, should they be required. The transmission circuits which are alive twenty-four hours per day should be placed on the top arm; that is, the trunk lines should occupy the position where there will be the least liability of coming into contact with the other wires or with the men working on the poles. All other circuits should be placed below series arc circuits occupying the lower arms, the distributing series circuit being placed on the house of the lower arms on outer pin occupied by such circuits. The bottom cross-arm should be used for such secondary circuits or low-tension lines as may be required. Space should always be provided for an extra arm on the pole for the erection of a transformer. Protective devices for each circuit may be classified as follows: Circuit-breaker, fuses for branch-circuits, and lightning arresters. Also indicating instruments as follows: Voltmeter, ammeter or wattmeter, and ground-detectors.

In the arrangement of the protective devices, it is desirable to locate as many of these as possible in the station or sub-station, for the reason that they are more readily inspected and kept in perfect working order, which insures the fulfilling of their functions when required. All circuits of 200-kw. capacity or over should be protected by means of oil circuit-breakers in preference to fuses, on all voltages over 1,000 volts. These circuit-breakers should be attached to both ends of the line, when two or more feeders are used and connected to the same bus; and there should be no other circuit-breaker or fuses which are automatic in action placed at any other part of the line. Small branch circuits may be taken care of when necessary by fuse-boxes, placed upon the first pole of the branch circuit. These fuse-boxes, however, should be avoided whenever possible. This can be accomplished by making a branch-circuit about the same as the main circuit, depending entirely upon the circuit-breaker in the station to protect both lines. When small branch circuits are desired, place such fuse boxes. These preferably should be an enclosed fuse of the cartridge-type mounted on a porcelain base, the whole enclosed in a fire-proof and water-proof compartment. This is usually an iron box with a cover and rubber gasket, clamped so as to make it water-tight.

Lightning Arresters.—Lightning arresters should be installed at both ends of the line, in the station and sub-station, on each conductor. Special care should be used in their installation, and provision made that in the event of a breakdown of the lightning-arrester, current may be interrupted by means of a circuit-breaking device.

Series Arc Loop Cut-outs.—These should consist of a mechanically operated switch which closes the circuit at the point of the loop and disconnects the loop from the main line. For the use of constant-potential circuits, there may be either a fuse-box provided with solid catches or fuses depending on the conditions. All of these devices being enclosed in fire and water-proof cases.

Before considering the actions of the safety-devices, it is necessary, first, to examine the faults which may develop and the functions which the safety devices are required to fulfil. If the condition of a wire parting is first considered, we have first the liability of the wire coming in contact with some of the other circuits; secondly, its liability to fall into the street, and, thirdly, its remainng suspended clear of all circuits and the ground.

The first condition: The effect of coming in contact with other wires, would immediately raise the voltage to the more powerful of the two circuits, so it is evident that the insulation of the other circuit must either be as good or there will be a liability of the insulation breaking down at some point on the weaker circuit. This will first be detected at the station by showing that the load is dropped from this circuit, and it demonstrates that the insulation of all circuits must be the same when placed on the same pole line, unless means are provided to take off extraordinary high voltages. This can be done by placing spark-gaps, which will relieve the high-tension from any low-tension circuits, or by grounding a point on the lower extension circuits.

Wires falling on the ground will indicate immediately in the station, on the ground detector, that there is a ground on that circuit, and instructions should be given that as soon as a ground shows on the circuit and the circuit is not carrying the load, to disconnect it.

The third condition will indicate in the station that the load is dropped and will not show a ground. The circuit should be cut off in this case also, and inspectors sent out to look after the trouble.

Fourthly, if a wire breaks and falls, crossing other wires of the same circuit, this will cause a rush of current on constant-potential circuit and immediately open the circuit-breaker. In the series arc-circuit it will cut out a portion of the circuit which will be indicated on the voltmeter, showing the necessity of regular voltmeter readings on such circuits.

Interference with Other Wires Falling or Coming in Contact with the Power-Circuits.—If these wires cross the power circuit and drop loosely on them, the effect will be to short circuit the power circuit on constant-potential circuits; the defect develops immediatley. The wires either burn off or an arc may be established which will burn off the power circuit, breaking the wires and the connection. The provision should be as the conditions shown for the breaking of a wire. A single wire may merely come in contact with one wire of a constant-potential circuit and assume the same voltage as that circuit; there will be no way of determining this at either the station or the sub-station, unless that wire was grounded and the ground indicated on the ground-detectors. In the event of this falling wire coming in contact with both sides of the series arc-circuit, a portion of the circuit will be cut out and indicated on the voltmeter at the station. Should it come in contact with only one wire of the circuit, no indication will be made at the station unless the wire be grounded. For this reason inspection should be made and all such wires changed so as to come before the power-circuit and not above it. This also demonstrates the necessity of placing protective devices on foreign wires which may come in contact with power circuits.

Lightning Storms.—The installing of efficient lightning arresters as specified may protect the apparatus at both the generating station and sub-station, but fail to protect apparatus at intervening points, par-

ticularly the transformers. It is possible that lightning may jump from primary to secondary of transformers during a severe storm. This would be indicated by the primary fuse blowing in the transformer, and after the blowing of the fuse from this cause, tests should be made of the transformer as follows:

It is essential that when a primary fuse on a transformer is blown through any cause, the secondaries should be disconnected from the transformer, and the latter tested to full-line voltage between the primary and secondary coils, so as to determine that there is no breakdown in the insulation between these coils.

There are two methods by which these tests may be readily made by the linemen without removing the transformer: First, take from the station a 600-watt transformer, connect its primary for the line voltage and its secondaries for 100 watts, and connect a 50-volt lamp across the latter. Attach one primary lead of this test transformer to

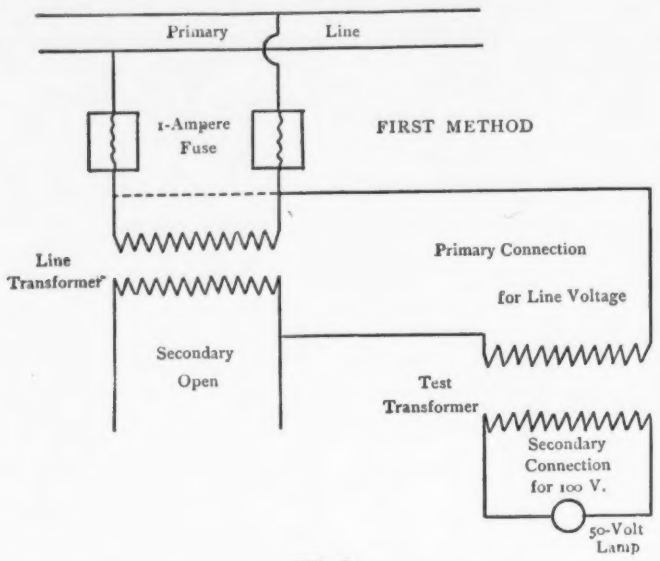


FIG. 1.

one secondary wire of the line transformer, and place one-ampere fuses in the primary cut-outs protecting the line transformer. Now connect the other primary lead of the test transformer, first to one and then to the other of the main primary lines. If the 50-volt lamp filament becomes red, the line transformer is defective, and should

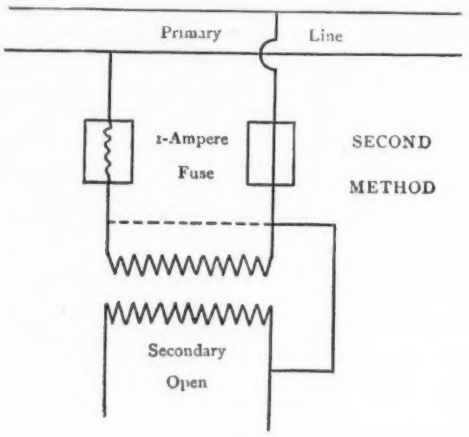


FIG. 2.

be returned to the station. Second method: If impossible to use the first method, proceed as follows: Attach a short piece of heavily-insulated rubber wire to one of the secondary wires leading from the transformer. Then place one-ampere fuses in the cut-outs, and connect the specially-insulated rubber wire first to one and then the other of the main primary lines. If the fuse blows, or a spark shows when contact is made, the transformer is defective and should be removed from the line.

In the event of lightning arresters being placed on the pole line, all such lightning arresters should be inspected after each heavy lightning storm.

Transformers.—Transformers when supported on the poles should be hung on an extra cross arm provided for that purpose. The primary leads from the line to the fuse box and to the transformer should be insulated with rubber-covered braid, for the line voltage. Transformers should not be attached to buildings or in such locations as to be handled by unauthorized people, and when they are placed in buildings they should be put in a separate fire-proof closet or room which is controlled only by the operating plant. As it is now the general practice to use oil transformers it is unnecessary to consider dry transformers. Inspection should be made to see that the cases are properly filled with oil. This should be done by an inspection force, and not by the men erecting the transformers.

Inspection.—The greatest safeguard in a transmission line is regular inspection. Lines can with advantage be inspected daily, not only on inspection from the ground, but a regular monthly inspection of all devices attached to the line when a continued service is desired.

It may be necessary on some parts of the line to introduce cable. This should be avoided whenever possible for the reason that the conductors are brought close together at this point and static discharge is liable to puncture the insulation; so means should be provided at both ends of the cable to take care of the static. This is best arranged for by a series of gaps of the lightning arrester type. Standard lightning arresters can usually be used for this purpose. They should, however, be provided with a small fuse in series with the connection to the line so as to prevent short-circuiting the lines in case of failure of the spark-gaps.

Overhead High-Tension Distributing Systems in Suburban Districts.*

By George H. Lukes.

The problem of building up and operating a satisfactory distributing system for the suburban towns and villages surrounding a large city presents many peculiar difficulties. It is rarely the case that the engineer is given the opportunity to lay out a complete system which can be operated economically and safely with a reasonably low first cost. The problem is more often one of reconstructing existing systems, making use of as much of the old work as possible and at the same time making provision for future growth. Obstacles are usually encountered in the work. Many different interests have to be satisfied, and in some cases the engineer is compelled to use types of construction which are not desirable, but necessary under the circumstances.

The villages surrounding a large manufacturing city are of several different types. The oldest ones are located on the lines of steam railways radiating from the city, and are residential in character. As transportation facilities are improved new suburbs are started at greater distances from the city. The older ones become more thickly settled and even grow to be cities themselves. Some of the villages are made up of people of moderate means, whose houses are fairly close together. Others are built up by wealthy people who buy tracts of land and build large houses, which they occupy but four or five months in the year. Later on, the manufacturing suburb makes its appearance, consisting of a group of factories and a small business district surrounded by the houses of the workmen.

In the process of time, electric lighting plants are erected in the larger villages and their pole lines are extended in time to the smaller villages near by to supply incandescent and street lamps. A large proportion of these small plants cannot be operated at a profit, an the result is a gradual deterioration in the stations and distributing systems, resulting finally in consolidations which bring large districts under the control of one company. It then becomes necessary to tie the various systems together, operating some of the stations as peak-plants and turning others into sub-stations, thus taking advantage of the fact that the peak may occur in the summer in one village and in winter in another.

Surburban business is so scattered that the cost of underground work is prohibitive and the distribution must be made by overhead wires. Public opinion is, however, intense in its opposition to overhead construction. The suburbanite objects to the multiplicity and unsightliness of the pole lines. He is in business in the city where the agitation against overhead wires has resulted in their being placed underground, and he refuses to believe that conditions are different in the country. In many communities local action has been taken compelling the use of joint lines by the electric light and telephone

* A paper presented at the December meeting of the American Institute of Electrical Engineers, New York.

companies. These have been erected and operated successfully in many cases without any great danger. Joint lines ought to be avoided if possible, and it is important that every effort be made to make the pole lines as unobtrusive as possible. The poles should be well painted with a dull color, such as a dark olive green; the wires should be kept taut and the connections made in a neat and symmetrical manner.

An overhead distributing system must be constructed so that the service will be reliable and not subject to frequent interruptions. The voltage regulation must be as good as possible and danger to life and from fire reduced to a minimum. This can be accomplished without adopting an extremely expensive method of construction. The great proportion of accidents and interruptions are caused by defects which are very easily guarded against, provided they are looked for. It is not the intention here to lay down rules for the construction of pole lines, but to draw attention to certain points which experience has shown to be often neglected.

Main Lines and Branch Circuits.—Main lines leading from stations should be on not less than 40-foot, and preferable on 45-foot poles. This gives plenty of room for additional circuits and makes it easier to cross above telephone and telegraph lines. The branch circuits can be on shorter poles, but it is not advisable to use poles shorter than 30 feet. Where branch lines are taken off, the poles should be double-armed and buck-armed. Transformers, fuses, lightning arresters and other devices should not be installed on main lines where it can be avoided.

Poles.—In the Middle West, the poles available at present are Michigan white cedar and Idaho cedar. Michigan poles are better proportioned than Western poles, and are longer lived. Michigan poles should have a top diameter of not less than seven inches. If Western poles are used, it is well to note that eight or nine-inch tops should be specified in order to obtain proper butt diameter. Michigan poles are sorted and sold under the specifications of the Northwestern Cedarman's Association, and it is, therefore, cheaper to buy under the above specifications and sort out to suit. Poles should be shaved, roofed, and given one coat of paint in the yard. Poles are painted in order to improve their appearance, but the question of whether or not it adds to the life of the pole is an open one. In setting, particular care must be taken to select the best poles for the corners, turns and ends of the line. If the line is on a highway that curves, set as many poles in a straight line as possible and make the turns on one or two poles, which can then be properly guyed. A line that changes its direction at every pole can never be held in position. Poles should be double-armed at corners, curves and ends.

Guying.—This is one of the most important features in pole line construction, and is often neglected. Corners, junctions, and ends should be carefully guyed. Wherever the line changes in direction, even if the change is very slight, a guy should be placed. Patent guys and land anchors should be used with great caution and only on light work. The best guy is the old-fashioned one consisting of a guy-stub, set at some distance from the pole with a galvanized iron anchor rod bolted to a slug buried in the ground. Strain insulators should be inserted in the guy wire and care should be taken to make sure that the anchor rod and guy wire attached to it are grounded electrically.

Cross Arms.—The best cross arms at present are made of Southern yellow pine. They should be straight grained, well seasoned, free from knots, and purchased unpainted. They are the first part of the line to give out. The action of the sun's rays causes the arms to crack on top and they soon rot around the pin-holes. The usual method of treating is to paint them with white lead and oil, but in the West cross-arms boiled in carbolineum have been used to some extent. The matter of the proper dimensions and pin-spacing for cross-arms has not received the attention it should, and it is high time that an attempt be made to standardize 4-6 and 8-pin arms for use on circuits up to 5,000 volts. The proper 6-pin arm for such use should have approximately the following dimensions: Section, 3¼ inches by 4¼ inches; length, 8 feet; spacing, between pins about 16 inches, between pole pin about 22 inches. Cross arms for junction holes should be of special size with greater distance between pins.

Insulators.—The ordinary deep-grooved, double-petticoated insulator has proved satisfactory on 2,000-volt incandescent and 4,000-volt arc circuits. It is perhaps advisable to use triple-petticoat insulators on 4,000-volt polyphase work.

Fuse-blocks and lightning arresters are sources of trouble on pole lines. In some instances systems have been operated entirely without fuse-blocks on the outside lines, excepting, of course, the transformer blocks. The best plan is to install them on branch lines where there is a chance for trouble. Lightning arresters should be installed to protect groups of transformers and branch lines. They should be frequently inspected and the ground wires tested.

Transformers should be hung on double arms below the lowest arm. If they are of large size the arms should be extra heavy and bolted securely to the pole. Methods of bringing the primary wires down from the circuit to the transformer are various, and all are open to objections.

It is usually impossible to keep a regular arrangement of circuits upon cross-arms for the reason that as the business grows, circuits of all kinds are added. It is very desirable, however, that circuits be kept in the same relative position throughout their length in order to facilitate tracing. Houses should be, as far as possible, grouped upon three-wire secondaries which should be carried alone on the lower arm. The installation of 200-400-volt, three-wire secondaries would facilitate this work wonderfully in scattered districts. The neutrals of three-wire secondaries should be grounded on the first pole away from the transformer.

All series alternating arc lamps should be provided with absolute cut-outs and high-voltage insulators in the lowering cable. Windlasses for raising and lowering lamps should be permanently grounded and an arc lamp when suspended from span-wires should be connected so that should it fall, the lamp will not fall toward the windlass but away from it.

The importance of frequent inspection of pole lines cannot be overestimated. Old pole lines can be made very reliable, provided they are well guyed and weak points kept in repair. For inspection work, linemen of considerable experience are needed, because only long years spent in repair work gives the ability to predict where trouble is likely to occur.

Accidents caused by overhead wires are remarkably infrequent, considering the number of miles of pole lines operated. They occur most often to electric linemen, less often to telephone linemen and very rarely to citizens. Accidents to linemen can largely be prevented by employing on live work only steady and tried men and using the inexperienced men and floating linemen on new construction work. Accidents to telephone linemen are mostly the result of want of care on the part of the men themselves. Accidents to citizens can be reduced to a minimum by care in constructing and maintaining lines.

The danger from fire is in the possibility of high-voltage current reaching buildings; first, through defective transformers, and, secondly, through crosses between primaries and telephone wires. The first can be eliminated by grounding the secondary; the second can be made remote by proper co-operation between electric light and telephone companies in the erection of junction poles and substantial construction. The danger from fire is somewhat overestimated, and it is to be sincerely hoped that any restrictive regulations will not only be carefully considered before final action is taken, but worked out in actual practice to determine whether or not their enforcement would introduce risks which would more than offset any advantage gained.

Tariff Agitation in England.

The Tariff Reform League, of England, has announced the names of twenty-three persons who have accepted invitations to serve as members of the Tariff Commission referred to in a recent speech by Mr. Chamberlain at Leeds. The League also gave some particulars of the work the commission will do.

It is understood that the commission has not been packed with men committed to some particular idea, but that it is made up of men of open minds, who will study the tariff question diligently from all points of view, and who will endeavor to draft a scheme of protection satisfactory to all whose interests should be consulted. Among those who have accepted are Sir Arthur Keen, vice-president of the Institute of Mechanical Engineers and of the Iron and Steel Institute; Sir W. T. Lewis, president of the South Wales Institute of Engineers; Hon. C. A. Parsons, of steam turbine and electrical engineering fame; Sir A. Hickman, member of the Council of the Iron and Steel Institute; Mr. C. Allen, nephew of Sir Henry Bessemer, and Mr. Alfred Mosely, the millionaire educational reformer. These are good men and typical.

New Telephone Patents.

SUBSCRIBER'S CIRCUIT.

A new common-battery system of subscriber's station circuit has been designed by Mr. W. W. Dean, of Chicago, in which the various parts have been arranged in a manner to suppress receiver "clicks." These clicks, so prominent and disagreeable with many central energy systems, seem to be almost wholly traceable to breaking the continuity of the receiver circuit, while highly inductive apparatus is contained therein.

In Mr. Dean's circuit, which is shown in Fig. 1, it will be noted

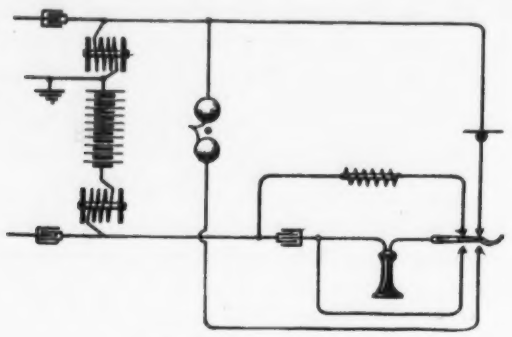


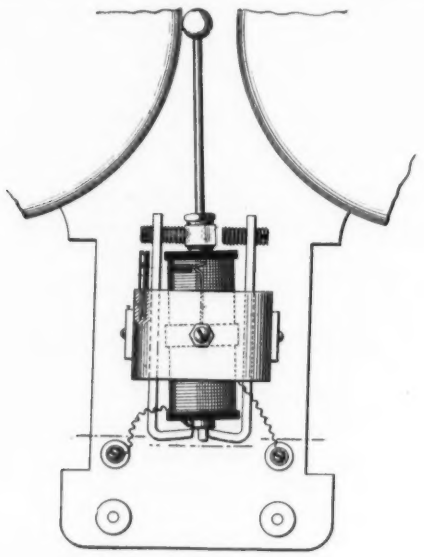
FIG. 1.—DEAN CIRCUIT.

that at the instant of breaking the receiver circuit in the commutation of the local circuit a low resistance shunt is always provided for the receiver. At the depression of the hook switch the shunt circuit, that containing the coil shown immediately above the receiver, extends around both receiver and condenser in series. The second shunt, that for the rising switch hook, is a low resistance strap directly about the receiver.

At first thought it might seem that the first-mentioned shunt, containing an impedance coil, could not be effective. However, the requirements of the circuit permit a coil of impedance rather low compared to that of the condenser and receiver in series. Mr. Dean has recently obtained a patent for this circuit, which he has assigned to the Kellogg Switchboard & Supply Company.

POLARIZED BELL.

In Fig. 2 is shown a rather novel type of polarized bell for which a patent has been granted to Leland Moore, of Brooklyn. This bell



MOORE PARTY LINE BELL.

is probably designed as a load-ringing extension bell, and in distinction to usual custom the coil forms the vibrating portion. This coil is wound in two sections, the separator serving as a seat for the trunions. Spanning the coil is a heavy permanent magnet carrying pole extensions between which the ends of the coil core vibrate. The pole extensions for one end of the core engage directly with the core and are fixed in permanent position. Those for the other end, however, carry small cylindrical pieces threaded through them, and thus providing adjustment.

When it is desired to have the bell respond to current impulses of one polarity only, as required for some party line systems, one of the screw pole tips is made non-magnetic, and the coil is provided with a biasing spring, as shown in the cut.

SELECTIVE SYSTEM.

A step by step selective system has been patented by E. O. Hood, of Hingham, Mass. This system, like all others of the type, depends upon a synchronized action of the switching apparatus at all subscribers' stations. This, of course, is at once a material point against the system, even though arrangement is cleverly made to restore all switches to the normal automatically immediately after a call is made

SIGNALING MOVING TRAINS.

Another system for signaling moving trains in which a contact is maintained between the train and a stationary conductor has been recently invented by James Edgar, of England. The chief novelty lies in the use of a slotted tube beside the track within which the stationary conductor lies. This conductor is threaded through the train contact which slides along in the tube, and it makes its connection to the live wires through wide metal studs secured at intervals in the bottom of the tube.

Recent Electrochemical Developments.

COPPER REFINING.

A patent granted on December 15 to Mr. Alfred Schwartz, of New York City, relates to a novel arrangement of the electrolytic tanks in a copper refinery which is intended to provide proper circulation and an easy method of removing the slimes. The tanks are arranged in tiers above each other; below all of them there is a basin for the electrolyte in which it may be heated to any suitable temperature. From this basin the electrolyte is pumped upwards into the top of the uppermost tanks. The electrolyte flows out of these tanks at the bottom and flows then into the top of the next lower tier of tanks and so on until it finally returns to the basin at the bottom. Each of the electrolytic tanks is provided at its outlet at the bottom with a filter to retain the slimes. An automatically-controlled valve governs the outflow through this outlet. The method is quite different from that in general use in our copper refineries, where circulation is accomplished by an overflow, but is restricted in amount, in order not to disturb the slimes.

ELECTROLYTIC BLEACHING.

On December 15 a further patent concerning electrolytic bleaching was granted to Mr. Marcus Ruthenburg, who is best known by his work in the electrometallurgy of iron and steel, but is also interested in electrolytic bleaching, as was noticed in these columns some time ago. He impregnates the stuff to be bleached, for instance, paper pulp, thoroughly with an aqueous solution of sodium chloride with some addition of hydrated calcium oxide, and then sends a current through the system, thus producing anodically a bleaching agent. The bleaching effect is claimed to be greater than if the bleaching agent is made separately and the paper pulp treated with it afterwards.

ELECTRIC FURNACE METHODS.

Of four patents recently granted to Mr. P. Danckwardt, of Deadwood, South Dakota, two refer to the production of alkaline cyanides. In an electric furnace he brings to reaction a mixture of magnesium nitride, sodium fluoride and calcium carbide in an atmosphere of nitrogen. The products are sodium cyanide, calcium fluoride and magnesium. The mixture of sodium cyanide and calcium fluoride is drawn off from a tap hole, while the gases of magnesium developed combine with the nitrogen introduced into the furnace and form again magnesium nitride. This on coming into contact with a new charge of fluoride of sodium and calcium carbide will again cause the first reaction, and so on. In the second patent he produces sodium cyanide simultaneously with metallic sodium. He subjects a mixture of sodium nitrite, sodium fluoride or sulphide and calcium carbide to the heat of an electric furnace. A mixture of sodium cyanide and calcium fluoride or sulphide is drawn off from a tap hole, while the metallic sodium volatilizes and is collected in another receptacle.

A third patent relates to a method of separating valuable metals from matte or ore and consists essentially in heating a mixture of the matte or ore with limestone and carbon in an electric furnace with an exclusion of air. The amount of carbon and limestone must be chosen so that the carbide which is being formed will be just sufficient to reduce all the sulphides or arsenides of the valuable metals

to be separated (like copper, lead, gold, silver, etc), but not sufficient to reduce the iron sulphide to the metallic state.

The fourth patent relates to a method of recovering zinc from sulphide ores and consists essentially in treating in the electric furnace a mixture of the ore with sodium sulphate, limestone and coke, and sufficient fluxes to slag off the impurities of the ore in the presence of a large excess of carbon. The furnace action is again carried out under exclusion of air. The furnace reaction is assumed to be as follows: First, the sodium sulphate is reduced to sodium sulphide under evolution of carbon monoxide, and as the temperature rises to the formation point of carbide, this carbide reacts with the sodium sulphide, forming calcium sulphide and metallic sodium, which latter *in statu nascendi* attacks the heavy metal sulphides, regenerating sodium sulphide and setting the heavy metals (zinc, lead, copper) free.

New York Central Electric Plans.

Details and illustrations have already been presented in these pages with regard to the plans and plant for equipping the New York City terminal and suburban lines of the New York Central Railroad Company with electricity. No authoritative statements have been given out since, but further data have become available. It is understood that the road will be equipped with third rail on the main line from Forty-second Street to Croton, and on the Harlem road from Forty-second Street to White Plains. On the New York & Putnam about five miles of the road will be thus equipped. It is quite probable that the Central may establish a new division point at Croton, thus obviating the present change of engines at Albany.

In regard to the electrical equipment of the road, so far the committee has decided upon the construction of two main power houses, one at Port Morris and the other at Yonkers. There will also be erected twelve rotary sub-stations at intervening points along the main line. The engineers estimate that the main power houses will cost one and a quarter millions each, and the smaller stations $300,000 each, bringing the cost for construction and equipment of the power stations up to $6,000,000. In addition to this, the electric locomotives, special cars, the third rail and other needed accompaniments will bring the cost of the electrical equipment of the road up to $12,000,000.

A committee is considering what connection can be made with the Subway system. Many of the directors are against a train connection with the Subway for the reason that the Central would have to install a new style of suburban passenger car which could be operated in the tunnel, as any of the existing passenger cars would be too large for this service. The depressing of the tracks in the Forty-second Street yard is now progressing in three divisions, so that traffic may not be interrupted. This and the new terminal building, if decided upon, will bring the total of expenditure required for these purposes up to $20,000,000. In addition, the extra improvements will cost about $5,000,000. It is conservatively estimated that the new terminal improvements, together with the complete electrification of the terminals, will cost $25,000,000.

American Association for the Advancement of Science.

The annual meetings of the American Association for the Advancement of Science and of the American Physical Society will be held in St. Louis, Mo., in "Convocation Week," from December 28, 1903, to January 2, 1904. The opening session of Section B will be held on Monday, after the adjournment of the general session, probably about 11 o'clock A. M., at which time the session will organize, elect committees, and transact other suitable business. On Monday at 4 o'clock, the retiring vice-president, Professor Ernest F. Nichols, will give an address on "The Infra-red Spectrum." The Section will meet on Tuesday morning and afternoon, for the reading of papers. On Wednesday, December 30, the annual business meeting of the American Physical Society will be held, and the programme will consist of papers by members of this society. A regular session will be held on Thursday morning, while the afternoon will probably be devoted to a visit to the World's Fair Grounds. If the number of papers is sufficient, the sessions will continue through Friday and Saturday. All sessions for the reading of papers will be held in Room 317 of the Central High School Building. Room 313 has been designated as the smoking room for Section B and the Physical Society, and the business session of the Physical Society will be held in this room on Wednesday. The vice-presidential address, on Monday, will be given in Room B2. The Southern Hotel will be headquarters.

A number of interesting papers are listed, and Prof. E. Rutherford is to give a popular lecture on radium. Among the papers are the following: "Hertzian Waves Since the Work of Hertz," A. D. Cole; "A Simple Alternate Current Frequency Recorder" and "Iron Losses in Loaded Transformers," E. S. Johonnot, Rose Polytechnic Institute; "The Radio-activity of Ordinary Metals," E. F. Burton; "A Possible Method of Accounting for an Electrically Charged Sun," David Todd; "On the Position of Aluminum in the Voltaic Series, and its Use as a Positive Element in a Primary Cell," and "On the Theory of the Electrolytic Rectifier," S. R. Cook; "A Spectro-photometric Study of Flourescence," and "The Phosphorescence of Organic Substances at Low Temperatures, Preliminary Note," E. L. Nichols and Ernest Merritt; "A New Form of Frequency Indicator," A. S. Langsdorf; "On the Use of Nickel in the Core of the Marconi Magnetic Detector," Arthur L. Foley; "A Remarkable Distribution of the Carbon Deposit on the Bulb of a 'Hylo' Incandescent Lamp," Arthur L. Foley; "An Absolute Determination of the Electromotive Force of the Weston Cadmium Cell," Henry S. Carhart and George W. Patterson; "The Heating Effects of the Radium Emanation," E. Rutherford and H. T. Barnes; "Does the Radio-activity of Radium Depend upon its Concentration," E. Rutherford; "On the Electrical Conductivity of Liquid Films," Lyman J. Briggs; "The Charges Given to Surfaces by the Diffusion of Ions, and the Earth's Negative Potential," John Zeleny; "On the Velocity of Light in a Magnetic Field," and "On the Effect of a Magnetic Field on the Interference of Polarized Light," John Mills.

CURRENT NEWS AND NOTES.

WIRELESS TELEGRAPHY ON SHIPS.—Another steamship in distress has been helped out by her wireless system. A cable dispatch from London of December 19 says: "The Red Star Line steamship *Finland* left Antwerp at noon to-day, and later the wireless telegraph station near Ostend, Belgium, received a message from the operator on board saying that the steamer had gone aground near Flushing, Holland. The weather was thick. The ship is not believed to be in any danger. Assistance has been sent to her. She has about 150 cabin and 500 steerage passengers aboard."

TELEGRAPHING EXTRAORDINARY.—The London *Times* has been pushing the sales of its edition of the "Encyclopedia Britannica" in great style, and has just closed the lists. On December 18 it made a last effort to bring in the waverers and establish a record in telegraphic advertising. Thousands of persons throughout the kingdom having obtained specimen pages, etc., but not having given a final order, and had been registered carefully, and the next morning 130,000 of them received telegrams admonishing them to write then or "wire this morning, as subscriptions are coming so rapidly that immediate action is your only safe course." Hundreds of orders were received in answer to the telegrams.

MUNICIPAL TROLLEYS.—The Civic Federation of Chicago, a city which has had a big municipal electric light plant for many years, looks unfavorably upon proposed municipal trolleys. It points out that at least five years more must elapse until certain questions involving rights claimed by the companies can be settled in courts of last resort, and "five or more years of even poorer service do not present an attractive feature." It estimates the cost of necessary improvements in equipment and service at $15,000,000 or more, which must be invested by the city if it takes hold, besides such further sum as may be necessary to acquire the existing properties and on which it is hard to set limits. It naturally fails to see how the city will be able to raise this money. The success in the enterprises now within the city control does not, it says, compel the belief that higher success would crown efforts in the reconstruction and operation of the street railway systems, stating among other things that "in Chicago it costs fully 25 to 40 per cent. more to pave the streets under city administration than it does for like service under similar conditions of legitimate cost elsewhere." It therefore recommends an ordinance continuing the franchises for a limited term of years, "with a just and adequate provision for compensation."

MUNICIPAL ART.—Borough President Cantor, of Manhattan, has issued permits for the erection of two electroliers in Longacre Square, New York City, given to the city through the Municipal Art Society, which has already set one up at Fifth Avenue and Twenty-third Street.

PARIS LIGHTING.—Bartholdi has a new scheme for lighting Montmartre, Paris. The idea is to erect his tall monument in memory of the balloonists of the Siege of Paris either on the Place Pigalle or the Square Saint Pierre, and surmount the column by a large mica balloon, containing electric lamps.

CHICAGO A. I. E. E. MEETINGS.—On January 5, 1904, a meeting of the Chicago branch of the American Institute of Electrical Engineers will be held at the usual place, 1741 Monadnock Block, to discuss central station topics as suggested by the papers presented at the New York meeting, December 18, and possibly also two papers presented at the New York meeting, on November 20, which bear closely on central station work. On February 2 a special telephone meeting will be held, at which time papers and discussions on the automatic telephone exchange will be presented. All of these meetings give promise of much interest and large attendance.

ELECTRIC CLUB JOURNAL.—The Electric Club, of Wilkinsburg, Pa., will, on February 1, issue the first number of the *Electric Club Journal.* Besides printing the transactions and proceedings of the club, the *Journal* will reprint papers read before societies and conventions which are appropriate in character, but not readily available to members, and contain editorials, engineering data, descriptions of shop practice, etc. The circulation will not be restricted to club members, but the privilege of subscribing extended to those who wish to fit themselves for practical engineering. Since the educational feature of the club work comprises a weekly lecture by an engineering authority and several meetings during the week of engineering sections, the amount and the character of the original matter available for the columns of the publication should render it of much value to the general engineering public.

THE INTERSTATE COMMERCE COMMISSION, in its annual report just filed on railroads in the United States, says: "In the year ending June 30, 1903, the number of passengers killed in train accidents was 164, and of injured, 4,424; of employees killed, 895; injured, 6,440. Casualties from other causes, added to these, make totals of 321 passengers and 3,233 employees killed and 6,973 passengers and 39,004 employees injured. These numbers are larger by a considerable percentage than the corresponding numbers of the year last preceding. The report says that some railroads have willfully neglected to make correct reports of accidents on their lines. It recommends that no person under twenty-one be permitted to act as telegraph operator, as many disastrous collisions have occurred through the negligence or misconduct of youthful employees. The report says also that the block signal system should be made compulsory in order to prevent the continuance of accidents which are "a disgrace to the American people."

WINTER-EICHBERG SINGLE-PHASE RAILWAY MOTOR.—Maurice Latour, in a letter to the London *Electrician,* claims that the English patent recently issued on the Winter-Eichberg single-phase railway motor, an analysis of which patent appeared in our issue of last week, discloses that this motor is none other than his single-phase series compensated motor. It suffices, he says, to refer to the *L'Industrie Electrique,* 1902, p. 220, first column, last paragraph, where he had described very clearly the excitation by means of a single-phase alternating-current of a rotor provided with a commutator (see French patent 306,229 of December 12, 1901) when two auxiliary brushes short-circuited on one another are placed at right angles to the two brushes introducing the line current into the rotor. In addition, he says, his single-phase compensated motor of either the series or the shunt type, admits of such a simple and brief description that he could not understand the reasons for elaborating a series of claims of such a general and varied nature as those of the British patent, if the compensated single-phase motors were really intended to be covered by this patent. He considers it certain that his single-phase motor is interesting only because it is a compensated motor, and if this special quality is not desired, the simple repulsion motor suffices to obtain all speeds without the use of external resistances.

RUIN CAUSED BY BREAK OF HIGH-TENSION WIRES.—Through the breaking of a wire of the Chicago & Joliet Electric Railway, three railroad stations situated several miles apart were set on fire, while those at Lemont and Spencer were destroyed, and telegraphic communication with Joliet was almost entirely cut off. The circuit which feeds the power houses at Lemont and Summit runs from the plant of the Economy Light & Power Company at the Jackson Street dam of the drainage channel in Joliet. The pressure carried is 15,000 volts. The break occurred where the circuit passes six feet above the wires of the Santa Fé Railroad. When the contact was made, the current burned out every fuse in the Joliet office of the Western Union Telegraph Company and ended communication between Chicago and St. Louis on the Chicago & Alton Railroad; between Chicago and Kansas City on the Santa Fé and to all points west of Joliet on the Rock Island. The current entered the telegraph station on the Santa Fé at Lemont and set it on fire. The station was deserted at the time and in it were stored 500 pounds of dynamite awaiting shipment. The heroic efforts of Mayor Keig, of Romeo, and several others saved the village from destruction. In several other stations on the line of the Michigan Central, Santa Fé, Rock Island and Alton Railroads damage was done to the telegraph system and wires and instruments were rendered useless.

THE GERMAN CABLE.—Mr. R. Guenther, United States Consul-General at Frankfort, Germany, says, under date of November 5: "The contract between the German Atlantic Telegraph Company and the German Post-Office Department with reference to the construction of a second German-Atlantic cable between Borkum and New York, via the Azores, provided that the first part of this second cable between Borkum and the Azores should be completed for business at the latest at the beginning of the year 1904, and that then the German Government would pay a fixed sum of 750,000 marks ($178,500) for the year to the said company. The other agreements between the company and the German Empire become operative if the second part between the Azores and New York (the whole cable) is completed on January 1, 1905. A few days ago the first part of the cable, i. e., between Borkum and the Azores—was successfully completed, in spite of the extraordinary unfavorable conditions of the weather on the Atlantic Ocean this year. The first part of the agreement with the German Post-Office Department has, therefore, been fulfilled according to programme. Without considering the pecuniary advantage resulting to the German Atlantic Telegraph Company through this stipulated payment on the part of the Empire on account of the existence of a double cable the cable traffic between Borkum and the Azores appears secure, as the probability that both cables should be interrupted simultaneously seems very remote, and as the new cable is in a condition to handle a considerable higher amount of traffic than the first one."

ELECTRICAL TYPESETTING.—The invention of Mr. W. S. Timmis, now being shown in New York City, known as the "lithotype," is based on the idea of using aluminum plates for all printing in which lithograph stones have been employed. The claim is also made that it eliminates all setting and distribution of type as well as matrix making, stereotyping and electrotyping. The plates are only 1/32 in. thick. "As at present constructed," says the inventor, "the lithotype consists of two parts or devices operating separately. Arrangements, however, have been made to co-ordinate these parts. The first consists of a small machine comprising a keyboard similar to the ordinary typewriter keyboard, perforating device to perforate a paper ribbon or strip of any required length, and a counting device. The perforating device is operated electrically and controlled by the depression of the keys. The machine automatically takes care of the spaces between the words. The perforated slip goes directly into the second part of the combination, which operates to bring the printing member into position, so that the selected character is directly opposite the printing point. The character is then inked, the paper is moved up to the character, and the impression is taken therefrom. This action is repeated for each character until the line is completed, when the paper-carrying device returns and moves for the new line. The transfer thus obtained is now ready to be impressed on the surface of the prepared aluminum plate. The plate, with the imposed transfer, is put under pressure, the paper is washed off, the impression thus made is 'rolled up,' and then, with a few finishing touches, is ready for the press."

A RAT STARTS FIRE PANIC.—Fifteen big fire gongs were set clanging and as a consequence a number of Senators and members of Congress were brought flying to the National Hotel lobby, Washington, in various stages of disarray because a hungry rat in gnawing the insulation from an electric alarm wire, had short-circuited the same.

TAKES PICTURES WITH PITCHBLENDE.—Prof. Alja R. Crook, of Northwestern University, notes independently that there is sufficient radium in pitchblende to make it possible for a photograph to be taken by it directly. By winding tin wire around a sensitive photographic plate and wrapping the latter in several coverings of black paper to exclude the light, the radium rays from the pitchblende passed through the paper and made an impression on the sensitive plate, so that when the plate was developed it showed where the wires had been wrapped around it. Prof. Crook states that the value of the experiment lies in the proof of a new way in which to discover radium in minerals.

A. I. E. E. PHILADELPHIA MEETING.—At a meeting held December 6 at the Engineers' Club of the Philadelphia local branch of the American Institute of Electrical Engineers, Mr. Lamar Lyndon read his November paper on "The Comparative Behavior of Floating and Booster-Controlled Batteries on Fluctuating Loads." Mr. E. F. Northrup gave an abstract and discussion of Mr. Addicks' paper on "The Electrical Conductivity of Commercial Copper," and Prof. Joseph W. Richards, of Lehigh University, an interesting address on "The Energy Absorbed in Electrolysis." The discussion of the papers, which was interesting and spirited, was participated in by Messrs. Woodbridge, Blizard, Lyndon, Clauder, Hewitt, Richards, Northrup, Hodges and Sanville. After the discussion Messrs. W. L. Hodges and John Kelly showed the talking arc lamp. The experiment was very successful. A number of phonographic records were given out by the arc, as well as the human voice. The phonograph was operated and the speaking was done in a room remote from that in which the lamp was exhibited.

LETTER TO THE EDITORS.

Theories in Wireless Telegraphy.

To the Editors of Electrical World and Engineer:

SIRS:—I regret that through indisposition I have not been able to reply earlier to Prof. Fessenden's letter in your issue of October 31 last.

I may say without further parley that I am disappointed at the bellicose attitude taken up by Prof. Fessenden, which I do not think was altogether called for by my letter in your issue of October 17, and, I fancy, he will find that in his anxiety to make out as strong a case as possible he has laid himself open to very serious criticism. The dogmatic way in which he lays down the law as though no one but himself has really studied the theory of wireless telegraphy, is amusing. He points out some imaginary blunders I have made, but which are really his own. He also makes the unwarranted and wholly erroneous assumption that I have made no experiments and infers that I am a "lucky guesser." It may surprise Prof. Fessenden to know that I have made a large number of experiments in wireless telegraphy and that I have been associated with the practice of the subject to an extent at least comparable with Prof. Fessenden's own association therewith, and for a longer period.

I have yet to learn that my contention regarding the "sliding wave" theory, viz.: that it was first published by me in May, 1899, is wrong. I contend that in this publication the propagation of waves over the surface of the earth, as opposed to space-propagated waves, was first advanced as an explanation of wireless telegraph effects. On the strength of this theory I predicted that the curvature of the earth would have little or no effect on transmission. As to the theory being a "lucky guess," I leave that to readers of the articles in question to judge. Personally, I think it was a theory logically deduced, and was, Prof. Fessenden notwithstanding, largely the result of reasoning on my own practical observations.

Prof. Fessenden says that, according to my theory, the intensity varies as the distance (I presume he means *inversely*). This would only be the case under theoretically perfect conditions. The surface traversed would have to be perfectly conducting and free from excrescences. Resistance of the surface would absorb energy and the presence of excrescences of a size comparable with the wave length and sufficiently abrupt, would reflect the waves, and also give rise to space-propagated waves with consequent dissipation of energy. Again, the strength of transmission would be largely affected by the degree of transparency of the atmosphere to these waves. Ionized air would and does absorb much of the energy from the waves, according to the degree of ionization present. Hence, Prof. Fessenden's argument on this score falls to the ground.

Quantitative measurements, especially in wireless telegraphy, may be wrongly observed or wrongly interpreted, and are equally dangerous in either case. Like statistics they must be intelligently applied or they will lead to erroneous conclusions, and this I make bold to suggest is just what Prof. Fessenden has been doing. How he can possibly argue that the intensity can vary with the square of the distance on any "sliding wave" theory under perfect conditions of transmission, is quite beyond me. When this is the case the waves are "space propagated." That is, they are spread over a spherical or roughly spherical surface and not along a simple circular belt.

I have carefully read the remarks made by Prof. Fessenden in 1899 on the sliding wave theory and published in the *Transactions* of the American Institution of Electrical Engineers for November, 1899, and fail to find that the theory there given is other than that advanced by me, but very crudely explained. I also notice that he does not even try to claim it himself, but endeavors to ascribe it to Heaviside and others.

Prof. Fessenden's main idea appears to be that the waves used are not Hertzian waves, but a new type which he was the first to recognize. This view of the case will take considerably more substantiation than Prof. Fessenden has yet given, especially in view of the fact that he has undoubtedly gone astray on the question of phase difference between magnetic and electrostatic energies in the waves, as per his British and American patent specifications. What ground has he for the statement that the Lodge waves or any true waves have electric and magnetic energies out of phase? In electric oscillations this is the case, but in traveling waves it is not and cannot be. In any true waves, whether ether waves or waves in matter, the kinetic and potential energies are equal and in phase. In fact, when we say that the magnetic and electric energies in any harmonic disturbance are equal and in phase it is simply another way of saying that the disturbance is a traveling one, i. e., a wave. Arrest a wave, or stop it traveling, and it at once becomes an "oscillation" where the electric and magnetic forces are out of phase.

Prof. Fessenden appears to be mixing up so-called "stationary waves," which are really oscillations, with true waves traveling with the velocity imposed on them by the medium in which they exist. He lays claim to have discovered a fact which was known before electric waves were discovered. He has also "discovered" several other mare's nests. He says that I have not yet recognized that no currents exist in the surface over which the waves are propagated. This is quite true, inasmuch as an electromagnetic field localized about a conductor constitutes a current in that conductor from one point of view. And I contend that Prof. Fessenden has not yet proved that this view of the matter is incorrect. He puts a "barreter" in a horizontal earthed wire and gets no result. Why? Because his "barreter" is not sensitive enough to detect the minute and momentary currents which would exist in this small section of the whole path of traverse. In other words, his "barreter" is at best but a shunt to a conductor of great size—a circular belt of the earth's surface. He then puts it in a vertical wire and gets a considerable effect. Why? Because the vertical wire collects and holds to itself the energy or some part of the energy from space a quarter length wave around itself in virtue of the wave being arrested and oscillations set up about the conductor. This point I cannot hope to make clear to Prof. Fessenden in a communication of this kind, but I can assure him he will yet learn a few facts about electric and other waves of which he is evidently not at present aware.

My experiments do not confirm Prof. Fessenden's table of relative sensitiveness of various types of receivers, and in this matter I am convinced that Prof. Fessenden's quantitative measurements have gone astray. Quantitative experiments are all very well, but they can be wrongly carried out and incorrectly interpreted, and I have little doubt that one of these factors is concerned in this case. The Marconi type of filings coherer is set down as possessing much less sensitiveness than the magnetic detector. There may sometimes be a little margin in favor of the magnetic detector, but I find that when a well-made and reliable filings coherer is connected in a *properly*

tuned and efficient circuit with efficient transmission there is surprisingly small difference between them. I have followed all or most that has yet been published regarding Prof. Fessenden's methods and am perfectly assured that he has not yet treated the filings coherer at all fairly in this respect. Until such time as Prof. Fessenden's quantitative results are fully confirmed by independent investigators I cannot accept them as correct. My own investigations do not bear them out.

I cannot hope that this communication will be at all convincing to Prof. Fessenden, but I do not intend at present to discuss the matter further, as I hope shortly to more fully explain my views elsewhere; but let me conclude with one note of cordial agreement. There has for some years past been an absurd notion hanging around that by shaking up the earth's potential or "wobbling" its charge, wonders in the way of wireless telegraphy can be achieved. This is a chimera, for several reasons. In the first place, one would have to use a conductor extending far away out into space to shake the potential, and in the second place no use could be made of the shaking potential any more than the shaking of the potential of a hollow conducting sphere could be made use of by a person inside the sphere. The screening is just about as complete in one case as in the other.

London, England. J. E. Taylor.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

Dynamos, Motors and Transformers.

High-Speed Direct-Current Machines.—Zinner.—An illustrated article on direct-current machines coupled directly with steam turbines. The high speed requires special devices to insure sparkless commutation. For good commutation it is advantageous to insert non-inductive resistance in the short-circuited coils in order to counteract, at least partially, the effect of the reactance voltage. For this purpose mechanical arrangements have been devised by which either in the commutator or in the brushes a sufficient amount of resistance is inserted which manifests itself fully in the short-circuited coils, but does not increase essentially the total resistance of the circuit. An arrangement of this kind by Seidener is shown in Fig. 1, in which between any two ordinary segments, 1^1 and 1^2, an auxiliary segment, h^2, is inserted. Each auxiliary segment is connected with the next main segment (according to the direction of the rotation) through non-inductive resistances, w, as shown in the illustration.

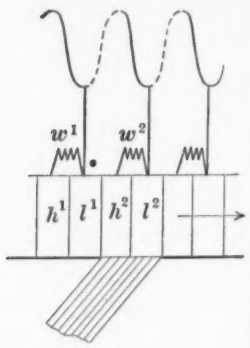


FIG. 1.

For machines of normal speed very favorable results have been obtained with this device, but for steam turbine generators the resistance, w, would become too great since the reactance voltage is very high in this case. For generators running at very high speed there will, therefore, always be a larger or smaller reactance voltage, which is to be overcome by an opposite commutation e.m.f. The author comes to the conclusion that for the rational design of such machines it is necessary to produce a special field for the commutation, independent of the magnetic field, fixed in space and changing automatically in intensity with the load. This may be accomplished in two different ways: First, by producing the commutating field by means of special commutation poles, which are magnetically independent of the main field, and are excited by the armature current; a machine based on this principle and designed by Seidener is described and illustrated. Secondly, a common magnetic pole system may be used which carries, besides the regular exciting winding, another winding supplied with the armature current in such a manner that a special commutation field is produced. The most

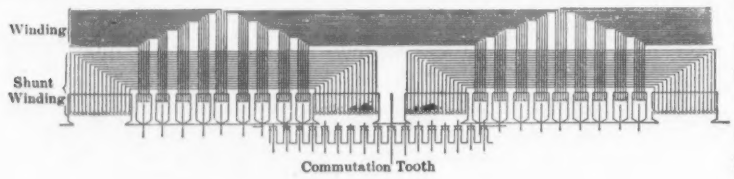


FIG. 2.

perfect example of this second principle is the Deri compensated machine, in which, besides production of the required commutating field, there is also compensation of the armature reaction. By simply displacing the brushes from the geometrical neutral zone, the Deri machine becomes a compound machine. For machines running at high speed there is danger of the production of strong additional short-circuit currents, if the commutation field is not properly designed. These currents increase the more the greater the differences between the field densities at the various points of the zone covered by the brushes. It is, therefore, necessary to try to get as flat a commutation field curve as possible within the zone of the displacement of the brushes. This can be easily accomplished by providing a special commutation tooth, as shown in Fig. 2, made of solid iron with deep radial slits. Details are given of the design of a machine of this type which, driven by a Parsons steam turbine at 3,000 revolutions, gives 510 amp. at 650 volts. The field has a two-pole shunt winding. The general arrangement of shunt winding and composition winding is shown in Fig. 2.—*Zeit. f. Elek.* (Vienna), November 29.

Design of Small Direct-Current Machinery.—Fynn.—A continuation of his illustrated serial. He advocates the choice of steel for the poles in order to get the shortest possible mean length of turn for the field coils, and, for the same reason, he advocates the use of round poles. Several pole constructions are discussed and illustrated. Concerning the shaft, he has found many illustrations of Fischer-Hinnen's contention that the portion of a dynamo shaft which is subject to the heaviest strain is that in the neighborhood of the commutator. The following formula gives very reliable results for ordinary sizes: The diameter in inches equals a constant multiplied by the cube root of the ratio of the normal hp to the number of revolutions per minute. The values for the constant which have been found suitable for the sizes under discussion vary from 10 for the smallest to 7.5 for the largest. In settling these values for the constant it is borne in mind that the machines, when used for crane work, with suitable altered winding, are required to exert a torque fully 2 to 2½ times the normal. Having thus settled the diameter of shaft through the commutator, he makes it at least equal to this through the armature and then steps down to the journals at each side, allowing for the necessary shoulders. In this way a shaft diameter through pulley end bush as arrived at, equal to about 0.8 of the diameter through commutator. He then discusses briefly the design of commutator and brush gear.—Lond. *Elec. Rev.*, November 27.

Dimensions of the Slots in Direct-Current Slot Armatures.—Müller.—A mathematical article in which he discusses the question how the dimensions of slots of an armature of given size must be chosen in order to make the capacity of the armature a maximum. He gives a formula for the best ratio between the breadth of slot and tooth. As a first approximation it follows from his formula that the best value of the ratio of the thickness of each tooth to the breadth of the slots is two-thirds.—*Zeit. f. Elek.*, November 29.

Automatic Motor-Starter.—An illustrated description of an automatic device made by a German company for either starting or stopping motors from a distance. A worm wheel, R, is attached to the lever of the starting box, shown in Fig. 3, arranged for three-phase work, and is driven by a worm, W, is a clockwise or counter clockwise direction, according to which of the two wheels, S and S_1, rotating in opposite directions, is coupled to the shaft carrying the worm, W. Both wheels are driven by the motor, but with different speeds; the one for starting, S_1, turns slowly, as compared with the other one, S, which is employed for switching off the motor. When the motor circuit is closed, the energized electromagnet, M, in attracting its armature against the pull of the spring, F, couples the worm, W and S_1.

The disc, *R*, begins to rotate until the pin, s_1, striking the lever, causes S_1 to become disengaged. On opening the circuit, the armature of *M* is released and the tension of the spring, *F*, is sufficient to cause the left-hand clutch to engage, connecting thereby the worm, *W*, to the pulley, *S*. The disc, *R*, is rotated until the pin, *s*, disengages the clutch. Another arrangement is also described, the chief difference

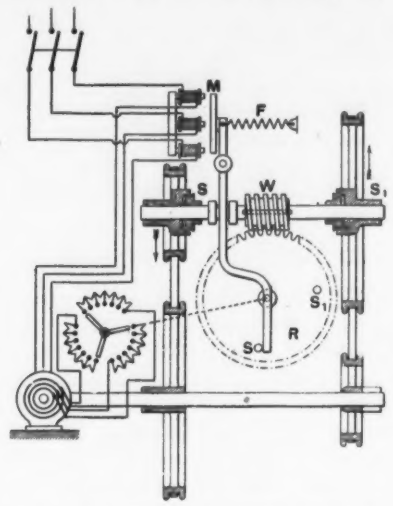


FIG. 3.—AUTOMATIC MOTOR STARTER.

between it and the above device being the adoption of a pawl and ratchet wheel instead of a clutch.—Lond. *Elec.*, December 4.

Electrodynamic Condenser.—SEIDENER.—An illustrated article on electrodynamic condensers which, compared with electrostatic condensers, have the advantage that they may be built in the same way as synchronous motors and practically for any required voltage. They have the valuable property of being self-starting. Two arrangements of Le Blanc and Swinburne are described. The author has devised a new machine of this kind which was originally intended to produce oscillating motion for mechanical purposes by electric means. In its external principles the machine is like an induction motor, the stator being supplied with direct current. The armature has one winding which, when at rest, is perpendicular to the plane of the stator winding. When the armature winding is supplied with an alternating current the armature is set into an oscillating motion.—*Zeit. f. Elek.* (Vienna), November 22.

REFERENCE.

Compound Synchronous Alternator.—KOLBEN.—The first part of a full illustrated translation of his recent German article on the latest type of Heyland machines, which was abstracted in the Digest.—Lond. *Elec. Eng.*, November 27.

LIGHTS AND LIGHTING.

REFERENCES.

Blue Prints.—An illustrated description of the Franklin electric blue print machinery, by which prints can be made at a speed between 1 and 10 minutes. The printing is done automatically, and the action of the machine being continuous, prints of any length can be made, or one separate print after another may be obtained in rapid succession.—*Sc. Am.*, December 5.

Electric Arc.—BLONDELL.—A discussion of the work done by Mrs. Ayrton on the electric arc, with special references to her book on this subject.—*L'Eclairage Elec.*, December 5.

POWER.

Steam Turbines and Reciprocating Engines.—BELLISS, MORCOM, WILKERSON, BARKER AND SWINTON.—Several communications on the question of the superiority of the steam turbine over the reciprocating engine concerning efficiency, especially when working with superheated steam. Bellis and Morcom defend the reciprocating engine operated with superheated steam, while the others are in favor of the steam turbine. Morcom gives a table of comparison between seven plants with steam turbines and seven plants with high-speed reciprocating steam engines. The figures show that the steam turbine stations on the average are quite 50 per cent. worse than the reciprocating engine stations, not only in the consumption of fuel, but in the total cost per unit of electricity produced. Barker and Swinton show, however, that this table of comparison is wholly unfair, since the average output of the reciprocating stations given in the table is about double that of the turbine stations, and the former have, on an average, a 50-per-cent. better load factor than the latter. Barker agrees that steam turbines cannot compete with reciprocating engines as regards economy of steam, unless they are first condensing, and, secondly, of units over 200 hp. The plant of the New Castle-on-Tyne Company, now operated by steam turbines, shows a works cost less than half the most favorable similar figure of 1.24 cent per unit given by Morcom for the steam engine plant of Leeds. The cost of coal and labor at New Castle and Leeds cannot differ very greatly. So this enormous difference must be due to matters of load factor and output and probably also to some extent to a superior economy of steam turbines over reciprocating engines.—Lond. *Elec.*, November 6, 13, 20, 27, December 4.

Blast Furnace Gas Engines.—An illustrated description of the blast furnace gas power plant at the Ilseder iron works in Germany. There will be six generating sets, one of which has been installed so far. It consists of a three-phase alternator of the fly-wheel magnet type, driven by a pair of gas engines, one on each side. The engines are of the two-cycle Oechelhaeuser type, each having two pistons working in one cylinder, and moving in opposite directions at the same time. These pistons are so arranged with regard to the positions of the admission and exhaust ports which they uncover at the end of their outward stroke, that no other valves are necessary. A pump is driven by an extension of the piston rod of the back piston, and forces the gas and the air respectively into the admission ports at a pressure of a few pounds per square inch; compression takes place when the pistons approach one another on the inward stroke. Regulation of speed is effected by varying the quality of the mixture of gas and air. The alternator is driven at 125 revolutions, the voltage being 10,000 and the frequency 50 cycles per second. The irregularity factor at full load is 1/350 and the fly-wheel effect is 2,500 foot-tons. The fly-wheel shaft is connected with the two crank shafts by couplings so that either engine may be used to drive the alternator while the other is laid idle if necessary. The alternator runs perfectly in parallel with the existing steam-driven generators even when only one of the gas engines is used. The governors of the engine are electrically controlled from the switchboard to facilitate paralleling.—Lond. *Elec. Rev.*, December 4.

Electric Power for Mining.—WARREN.—An illustrated description of a 2,000-hp electric power plant in Scranton for supplying power for the operation of electric locomotives, hoists, pumps, drills, lights, etc., at various coal mines of the Delaware, Lackawanna and Western Railroad. Power is transmitted by 2,300-volt alternating current to sub-stations at the mines provided with step-down transformers and synchronous converters for converting the current to 275 volts direct current for the mines. The equipment of the power plant is described and illustrated.—*Mines and Minerals*, December.

REFERENCES.

Steam Plant of Lausanne Sub-Station.—HERZOG.—An article on the steam plant of the Pierre de Plan sub-station, in which the high-tension direct current (Thury system) transmitted from St. Maurice is converted for use in the lighting and traction system of Lausanne. Should, on account of an accident, no direct current arrive from St. Maurice, the converting machinery may be driven by steam engines. There are three 400-hp steam engines, which are described in connection with detail drawings.—*Zeit. f. Elek. u. Masch.*, November 16.

Gas Engines.—GRAMYR.—An illustrated description of a gas engine installation, using Dowson gas, in a locomotive and machine shop in Winterthur, Switzerland. There are three gas engines of 100 hp and one of 40 hp. Illustrations are given of the installation and diagrams of the behavior of the gas engines.—*La Revue Tech.*, November 10.

Steam Trap.—GEIPEL AND CHINTZ.—Two illustrated communications on the rational designs of steam traps.—Lond. *Elec.*, November 6.

TRACTION.

Camden & Suburban Railway.—An illustrated description of the railway system of Camden, opposite Philadelphia, which comprises various suburban extensions from 7 to 12 miles in length. The company uses a bond consisting of cast-copper plates 100 mm. x 150 mm.,

with two grooves for the bond wires. Above the wires is a cast-iron plate with corresponding grooves, and both plates are drawn up tight to the web of the rail with two 25-mm. bolts. T-rail is used to a large extent in the suburbs. The company has about 24 miles of telephone wires and 38 telephones at different points. Lightning arresters are used every 1,000 ft. There are several novel features in regard to the power station, among them the method of making joints and piping, and an arrangement for recovering the cylinder oil from the water of condensation. The experiment has been tried of equipping one engine with tail rods and the other without tail rods. The experience with the tail roads indicates that it is possible to work the engine equipped with them at about 10 per cent. greater capacity. The fly-wheels are all enclosed in metal housings. The switchboard is also of a novel design. Two positive bus-bars are used and the equalizer bus-bar is on the negative side of the generators. This reduces the complications on the board and also the possibility of short-circuits between the equalizer and the ground. The company uses two circuit-breakers in multiple on each machine before they are connected to the bus-bars and thinks this more desirable than a single circuit-breaker. The method of connecting the booster to the switchboard is also novel, as this circuit-breaker is interlocked with the circuit-breaker of the motor operating the booster.—*St. R'y Jour.*, December 5.

Testing Rail Bonds.—An illustrated description of a method of Gerhart, involving the familiar application of a double-scale millivoltmeter in conjunction with means for taking the readings over a standard length of rail and across the joint to be tested. By comparing the two readings, the resistances of the joint can be easily determined. The novelty of Gerhart's method lies in the contact bar or pole, by which contact is made with the rail for the purpose of taking the reading across the joint and across the selected rail length. This consists of an oak piece of about 6½ ft. long and 1 in. square, to one side of which are attached four cold-chisel points which form the contact points with the rail. The oak piece is slightly bow-shaped, so that when placed on the head of the rail without pressure the piece will rest upon the two outer chisel points. Pivoted to the center of this piece is an upright which forms a handle and carries at its lower end one of the four contact points. This point and the contact point at one end of the bar are connected to the top scale of the millivoltmeter. They are so placed on the rail as to measure the drop on the standard length of rail. The third and fourth contact points are used to give a reading across the joint and are connected to the bottom scale of the millivoltmeter. By placing one foot upon the horizontal piece of the bar near the center a reading across the standard length of rail is obtained on the upper scale of the voltmeter. By placing the other foot on a plunger, the remaining contact point is placed to the head of the rail and a reading across the joint on the lower scale of the voltmeter is obtained.—*Street R'y Rev.*, November 2.

REFERENCES.

Cincinnati.—A long and fully-illustrated description of the Interurban Railway and Terminal Company, of Cincinnati, which has 108 miles of track in operation. There are two power plants. One contains two 400-kw, direct-current generators and two 500-kw, 10,000-volt alternators. The other contains two 500-kw, 10,000-volt alternators. The high-tension alternating currents are transmitted to four sub-stations, provided with transformers and synchronous converters. —*St. R'y Rev.*, November 20.

Paris Traction.—GUERY.—A continuation of his very long and fully-illustrated description of the electric installation of the railway Des Invalides à Versailles. High-tension, three-phase currents are transmitted over underground cables to three sub-stations, provided with transformers and synchronous converters. Each sub-station contains four 300-kw converters.—*L'Eclairage Elec.*, December 5.

Ipswich.—A note on the recently-opened tramway system of Ipswich. The power plant contains six steam-driven, direct-current generators, two of which have a capacity of 240 kw, two of 120 and two of 50 kw each. The two largest machines can be either used compound-wound for the traction load or as shunt machines for lighting. A storage battery of 248 cells, with a capacity of 400 amp.-hours, works between the outers of the three-wire system.—Lond. *Elec.*, November 27.

Third Rail and Trolley.—An editorial discussion of the relative advantages of the third rail and the trolley for high-speed roads. Under certain conditions each is preferable. Where trolley wheels run from 5,000 to 10,000 miles on a heavy interurban car, as they do in many cases, it is safe to assume that the trolley wheel is a fairly satisfactory method of obtaining current. On the other hand, there are certain points where the third rail is more advantageous.—*St. R'y Jour.*, November 21.

Motors as Emergency Brakes.—GOUGH.—An article in which the writer explains the connections through which motors can be used for emergency braking, with 2-motor and 4-motor equipments.—*St. R'y Jour.*, December 5.

Trackless Trolley in Scranton.—A description of an experimental line 250 meters in length, in operation in Scranton, Pa. The trolley wheels press against the wire from the inside and the trolley poles carry "bridges," which allow the trolley to pass by gaps in the trolley wire. A three-wire system can be used if desired.—*St. R'y Jour.*, November 14.

WIRES, WIRING AND CONDUITS.

Insulating Paints.—TOCH.—A brief article on electric insulating paints. The materials employed in the manufacture of insulating paints and varnishes consist principally of resins in a suitable solution. The addition of a metallic element would be decidedly harmful. The principal gums that are used in making insulating varnishes are resin, asphaltum, pitch, tar, Kauri, manilla, shellac and copal. The principal solvents are turpentine, benzine, benzol, acetone, alcohol, bisulphide of carbon, linseed oil, china wood oil, and in some instances water. Resin is very largely used as a gum, but in very fine work a solution of resin alone is rather dangerous.—*Electrochem. Ind.*, December.

ELECTRO-PHYSICS AND MAGNETISM.

Dispersion of Fog by Electricity.—LODGE.—An abstract of a (British) Physical Society paper in which he describes an experiment formerly made by him in which two pieces of wire gauze, connected to the terminals of an electric machine, were placed opposite each other in a chamber, through which a current of smoke was slowly passing. Upon electrifying the pieces of wire gauze the smoke ceased passing, the dust particles cohered, hovered in the air and were either driven to the sides of the chamber or fell to the bottom. In the case of mist, the electrification of steam in a bell jar converted it into fine rain. It seems, therefore, possible that rain might be produced by the electrification of a cloud. He later tried at Liverpool to disperse fogs by discharging electricity into them. For this purpose a large mast was erected on the roof of the college building, terminating in a bundle of points, to which electricity was conveyed from a Wimshurst machine by a wire supported by specially-constructed insulators. The discharged points may be supplemented by a gas flame. Upon one occasion the discharge of electricity from the flame was sufficient to keep a clear space of 50 or 60 yards radius in the dense fog. He suggests that this means may be utilized on a large scale to mitigate the disastrous river fogs. He had suggested to erect for this purpose a series of masts for positive discharges on one side of the river and a series for negative discharges on the other side, but he does not think that the glass influence machine which was very suitable for his experiments could be put in the hands of "practical" men. He has, therefore, devised the following method of producing high-tension direct-current: A high-frequency alternator (3,000 periods per second) supplies current to a primary of an induction coil while the terminals of the secondary are connected to a Cooper Hewitt rectifier. He found that the rectifying effect is much assisted by the outside tin-foil coating which surrounds the mercury electrode and which is connected to the positive terminal of the lamp.—Lond. *Elec.*, November 20.

Storage of N-Rays.—BLONDLOT.—An account of some observations made in connection with N-rays. He found that on concentrating N-rays with a quartz lens for some time upon a calcium screen and then taking away the Auer burner, the increased luminosity of the screen persisted as long as the quartz lens remained. The lens, in fact, possessed a kind of invisible N-ray phosphorescence. The same effect is shown by quartz plates as well as Iceland spar, fluorspar and glass. The reflective power of metals is enhanced by exposure to N-rays. This enhanced reflective power also persists for some 10 or 20 minutes. Lead becomes active in this manner on both faces, if one of them is exposed to N-rays for several hours at a time. Aluminum, wood, paper, paraffin do not store up N-rays, and the least trace of moisture completely eliminates the effect. Dry pebbles gathered in bright sunlight give out N-rays. The effect is not quite analo-

gous to phosphorescence.—From *Comptes Rendus,* November 9; Lond. *Elec.,* November 27.

Absorption of Cathode Rays and Molecular Theories.—LENARD.—An account of experiments concerning the absorption of cathode rays as a function of their velocity. He formulates a new theory on the constitution of matter. The ultimate constitution of the atom he calls the dynamid on account of its electric field, which deflects and arrests the electron in its passage. The dynamid may be regarded as an electric doublet whose moment may vary from one atom to the other. The atoms of the different elements are made up of different numbers of dynamids in exact proportion to their atomic weights. Every dynamid throughout the universe has the same mass, but the actual volume of the dynamids constituting a cubic meter of solid platinum is barely a cubic millimetre.—From *Ann. der Physik.,* No. 12; Lond. *Elec.,* November 27.

Induced Thorium Activity.—VON LERCH.—A description of a series of experiments made to determine the chemical behavior of the induced radioactivity shown by metals exposed for some hours to Rutherford's thorium emanation. He works on Rutherford's hypothesis, assuming that thorium gives rise to thorium rays, the latter to thorium emanation, and this again to induced thorium activity by a series of sub-atomic transformations. When metals after exposure to the emanation are dissolved in acids, the radioactivity acquired remains attached to them and reappears on precipitating them from the solution. "It may, however, be detached from the metals by electrolysis, and made to precipitate on the cathode." The author believes that the induced activity is a new element or series of elements, the main constituent having a position between copper and lead in the voltage series.—From *Ann. der Physik.,* No. 12; Lond. *Elec.,* November 27.

REFERENCES.

Photography by Electric Discharges.—An account of experiments made by Leduc in which electric discharges were directed on a sensitive plate so as to produce designs capable of furnishing motifs for ornamentation. Some photographs of very pretty ornamental patterns thus obtained are reproduced. A plate coated with gelatino-bromide of silver is placed with its non-sensitive side on a metallic leaf, which is connected with one pole of a static machine or an induction coil. The other pole is connected with a metallic point, placed on the sensitive surface.—*Sc. Am.,* December 5.

Radioactivity.—ALLEN.—An illustrated paper in which he describes some experiments and gives a very concise review of the subject of radioactivity.—Lond. *Eng'ing,* December 4.

Spinthariscopic Phenomena.—TOMMASINA.—An account of experiments which confirmed Becquerel's contention that the sparking observed in Crookes' spinthariscope is due to the cleavage of the zinc sulphide crystals provoked by the impact of α-rays.—From *Comptes Rendus,* November 9; Lond. *Elec.,* November 27.

Magnetic Storm.—MOUREAUX.—A report of the observations made at the Val-Joyeux Station during the magnetic storm of October 31.—From *Comptes Rendus,* November 2; Lond. *Elec.,* November 27.

ELECTRO-CHEMISTRY AND BATTERIES.

Copper Refinery.—MAGNUS.—A fully-illustrated account of an experimental determination of contact resistances and current leakages in an electrolytic copper refinery. The power lost in contact resistances appears to be of considerable amount. In a test with 4,000 amp. and a current density of 11 amp. per sq. ft., the tank voltage was 0.230, which was made up as follows: The drop between anode and anode bus-bar, 0.0330 volt; drop between cathode and cathode bus-bar, 0.0180; drop across the electrolyte, 0.179 volt. The last figure includes the drop across the layer of slimes on the surface of the anode, which is about 0.007 volt. The actual effective energy is 77.8 per cent., the energy lost in contact and transmission being 22.1 per cent. The results of tests on tank leakages are given in a drawing.—*Electrochem. Ind.,* December.

Edison Accumulator.—A brief editorial note on Hibbert's recent paper on the Edison nickel-iron battery. It is said that the cell itself is undoubtedly an excellent one and an improvement in several respects on the old lead cell, especially on account of its excellent durability. But it is expensive, and since lead traction cells of equal capacity, weight for weight, as Edison cells, and occupying less space, are obtainable, the whole matter almost resolves itself into the question whether the increased durability is worth the extra cost.—Lond. *Elec.,* December 4.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring the Form Factor of Alternating Currents.—ROSE AND KUEHNS.—An illustrated account of an investigation made in the German Reichsanstalt. The form factor of an alternating-current e.m.f. is the ratio of the effective to the mean voltage. For measuring it the following arrangement may be used: With the aid of a revolving-contact disc, the number of revolutions of which per second is equal to the frequency of the alternating current, there is impressed upon the measuring instrument only one-half of the alternating-voltage wave in each period, so that voltages all of the same direction, are impressed on the instrument; while in the other half period (in which the sign of the e.m.f. is reversed) the instrument is without current. In this way a pulsating direct current is supplied to the instrument and the mean value of this pulsating direct-current voltage is equal to one-half the mean alternating-current voltage. For measuring the mean value of the pulsating direct-current voltage, a wattmeter was first used as will be described below, because it was considered unwise to use the commercial D'Arsonval voltmeter for direct current, since on account of inductive action it might have given wrong results. Comparative measurements, made afterwards with a wattmeter and a voltmeter, gave, however, identical results. If the wattmeter is used for measuring the voltage, the voltage coil is connected to the pulsating e.m.f., while the main current coil is supplied with a constant auxiliary direct current. The wattmeter is thus changed into a voltmeter and can be calibrated as such with constant auxiliary current. By dividing the effective voltage found by an ordinary alternating-current instrument, by the double mean value indicated by the wattmeter, the form factor is found.—*Elek. Zeit.,* December 3.

REFERENCES.

Cable Capacity.—KATH.—A communication in which the author refers to a recent publication of Fleming on the measurement of cable capacity and gives an account of some older mathematical investigations of his own on this subject.—Lond. *Elec.,* November 6.

Testing Rail Bonds.—See the abstract under "Traction."

TELEGRAPHY, TELEPHONY AND SIGNALS.

Wireless Telegraph Transmitters.—DE FOREST.—An article in which the author says that throughout the various attempts which have been made to approximate in wireless telegraphy, even remotely, something of the accuracy in resonance effects so well known in acoustics, sufficient attention has not been shown to the necessity for generating at the transmitter a long train of but slightly damped oscillations. The rapid damping of the transmitter oscillations are due generally to two causes: First, that from losses due to radiation from the antenna (which are considered useful and necessary), and second, from losses resulting from leakage, heat and dielectric hysteresis, which are detrimental to an extent little appreciated. Of leakages from the antenna there will always be a certain amount. Through insulation, especially at the top of the mast, and from all guy ropes, is strongly advocated. A petticoat insulator giving large and dry surface insulation, ought to intervene between antenna and its support. Mechanical reasons render it advisable to use steel guys for the mast; but if these be completely insulated from the antenna the leakage to them through damp air, and indirectly by currents induced in them, renders it necessary to cut these guys into several short lengths, connected together by strain insulators (ropes with dead eyes or porcelains) and to most carefully insulate from earth at the bottom. In damp weather rope, especially if untarred, is but little better than wire. If the air is moist or a heavy fog prevails, the invisible brush leakage from the antenna into this semi-conducting medium gives the effect of a large fictitious capacity between antenna and earth, greatly increasing its natural period of oscillation, and requiring readjustment of the constants of the closed resonator circuit if it is intended to keep this and the antenna circuits in syntony. This apparent additional capacity is largely fictitious and, as a leakage, represents a large hysteresis loss, not recoverable, but producing additional damping to the oscillation. The same phenomenon exists even to a greater degree in the condensers themselves. In any Leyden jars or glass plate condensers in air, vivid brushes are observed extending for an inch or more at the edges of the tin-foil. The correct practice calls for the suppression of all brush losses at every cost, and the employment

of oil, or condensers otherwise sealed and sufficiently bulky, to give requisite safety with capacity. The Leyden jar is the element employed in wireless telegraphy which is least suited to its task. The amount of inductance existing in a battery of Leyden jars, when these are connected up as closely as possible, is surprising and little recognized. In a battery of say 10 jars connected in parallel he has found that the exact method of connection is of the utmost importance. The best arrangement is in a circle, with leads from all of the jars of exactly the same length. Otherwise there is a tendency for a series of discharges from the several jars in turn, and not from the battery as a unit. The heating of the spark-gap terminals is a proof of the losses existing in the spark. The wider the gap the greater the loss is through heating the column of air. A simple method of reducing this gap while maintaining the requisite high potentials, is to employ a series of small gaps between poles or discs of small curvature. There is nothing in a liquid dielectric, but considerable is to be said in favor of the spark in air under pressure, as reducing sparking distances and allowing an especially sudden disruptive break-down—a spark of high conductivity and slight damping. —Lond. *Elec.*, November 27.

REFERENCE.

Telegraphy and Telephony.—The quarterly summary of recent developments in telegraphy and telephony. The present installment refers to progress made during July, August and September, 1903.—*Elek. Anz.*, November 22, 26.

MISCELLANEOUS.

Finsen Light Cure.—Fyfe.—An illustrated article on the Finsen light cure at the London Hospital. The following statistics have been collected at the Finsen Institute from the end of 1895 to 1902; 804 cases of lupus were treated, of which 412 were entirely cured. The number of those whose cure is nearly complete with but slight traces of the malady is 192. The cases still under treatment number 117, of which 91 show an improvement and 26 remain about stationary. The treatment was interrupted for different reasons in 83 cases, by death or other grave malady 44, and for outside reasons 23, leaving but 16 whose treatment was stopped as being unsatisfactory. In the first stages of the disease the cure is almost certain.—*Sc. Am.*, November 28.

Accounts of Municipal Plants.—Walmsley.—A paper on depreciation and sinking fund in municipal undertakings. The author suggests that depreciation should be charged in all undertakings liable to waste, obsolescence or supersession on terms quite sufficient to recoup or renew the assets when required, without recourse at any time to reborrowing, repairs being charged direct to revenue year by year, so as to maintain the assets in efficient condition. Longer periods should be allowed for the repayment of loans, especially in undertakings of a permanent character, where there is no risk of obsolescence. Sinking fund should be charged separately without regard to depreciation. All these matters should be settled by a conference of all corporations, so as to establish a uniform treatment of depreciation and sinking fund in all accounts.—Lond. *Elec.*, October 30.

New Books.

Onde Hertziane E Telegrafo Senza Fili. By Oreste Murani. Milan: Ulrico Hoepli. 341 pages, 171 illustrations. Price, 3.50 lire.

Uniform with 800 other manuals, scientific and classic, published by Ulrico Hoepli, of Milan, Italy, is the present volume, entitled "Hertzian Waves and Telegraphy Without Wires," by Oreste Murani, professor of the Physical Institute at Milan.

The object of the work, it is stated by the author in the preface, is to present a simple and at the same time a complete treatise, and in this respect it is like nearly all the other Hoepli manuals. In the arrangement of the text three divisions are made, the first part dealing with the fundamental principles of electricity and magnetism in a manner similar to the treatment of these themes in preparatory text-books on physics; the second part is devoted to electromagnetic waves and the third and last portion of the book is given over to telegraphy without wires.

The different parts are divided into chapters and these finally are classified under sub-headings. There is nothing particularly new either in mode of treatment or subject matter contained therein, but every phase of electromagnetic phenomena in any way related to the principles involved in wireless telegraphy is touched upon and explained, and even of so remote a piece of apparatus as the storage battery the author has thought it well to say a few words. In the chapter on syntonic system of radiotelegraphy—a fine synonym, by the way, for wireless telegraphy—Prof. Murani brings out the importance of selective signalling and confines his data to the Marconi, Slaby-Arco and Braun systems.

In the closing chapter a review of the cruise of the Italian man-of-war, *Carlo Alberta,* with Signor Marconi on board, is given, and an all too brief a biography of the Italian inventor closes the work. Marconi, according to his compatriot, Murani, was born near Bologna in 1874, his mother, Annetta Jameson, of the well-known and well-connected Jameson family of Ireland, being his father's second wife. At Livorno the youth received his first instruction in science. Under Agusti Righi, the young man continued his studies and he was granted the use of the illustrious professor's laboratory, for it is said that Righi, even at this early date, determined that Marconi was no ordinary student. On his father's estate at Partecchio, near the Apennenes mountains, Marconi tested his first wireless telegraph, and then enlisted the sympathies of Sir William Henry Preece, of England, where wireless telegraphy may be said to have had its real beginnings. The history of both the inventor and telegraphy without wires since those memorable days are well known. From Murani's book it would seem that Marconi discovered wireless telegraphy and Righi discovered Marconi.

Continuous-Current Dynamos and Motors and their Control. By W. R. Kelsey, B.Sc. New York: D. Van Nostrand Company. 440 pages, 225 illustrations. Price, $2.50.

It has been said in connection with engineering literature that most engineers who are engaged in practical work who know how to do things, have no time to write about them, and those who have time to write do not have the thorough understanding of their subject that comes only from practical experience with it. While much of the book under review gives the impression that its author belongs to the latter class, there is part of it that shows familiarity with the principles and methods explained.

The first four chapters deal with the fundamental units, principles and laws of magnets and electric currents. The next four chapters give in detail the principal methods of winding armatures, with the relative advantages and disadvantages of each. Then comes the method of calculating the dimensions of the armature core and the size and number of armature conductors, together with the I^2R, hysteresis and eddy current losses in the armature core and windings; and a numerical example of an actual design is worked out in detail. Chapters X and XI deal with the mechanical design of shafts, bearings, brushes, etc. Chapter XII treats of commutation and Chapter XIII gives the broad principles of shunt, series and compound-wound motors, but does not go into methods of design in detail. It also describes various methods of control of speed. Chapter XIV deals briefly with various special classes of machines, such as boosters, plating dynamos, etc. Chapter XV gives methods of predetermining the characteristic curves of dynamos and motors, and the XVIth and last chapter gives methods of tests for magnetic leakage, heating, efficiency, etc.

The book is in the main a compilation and its merit must be weighed on the basis of the author's judgment in deciding what to include and what to leave out, and on his ability to give clearly and briefly the important parts of the articles and books from which his information was obtained. Judged from this point of view the book is of uneven merit. In the chapters on fundamental principles of electricity and magnetism and on armature winding and design, the material is well chosen, complete and clear, as it is also in those on field magnet and mechanical design.

The chapter on commutation is rather involved, being a mixture of two methods of analysis, the one approximately correct, the other entirely incorrect. The first analysis omits the influence of the changing resistances of the brush contact surfaces, assumes that reversal is entirely accomplished by the lines of force from the pole tip, and that the injury to the commutator is caused by the current jumping across the gap between the brush and the receding segment. The fallacy of these assumptions was first pointed out in Mr. Thorburn Reed's paper on "Sparking, its Causes and Effects," read before the American Institute of Electrical Engineers, December, 1897; and the theory then set forth that the injury to the commutator is done before the segment leaves the brush is now generally accepted. The second analysis, taken from the paper by Arnold and Mie, mentioned on page 288, is based on Reid's paper and is in accordance with the now generally accepted theory. Most of the constants for prac-

tical commutator design are unfortunately based on the incorrect analysis, a fact which the author seems to recognize in his criticism of Hobart's criterion of sparking on the ground that it assumes a sine law of change of current. Hobart's criterion is, in fact, of small value, since in any well-designed machine the variation of contact resistance, which follows a straight line law, is the main factor of commutation, while Hobart's criterion does not take this variation into account at all. Messrs. Arnold and Mie's criterion given at the bottom of page 289 is correct, and the chapter as a whole would have had much more practical value if the constants and curves of their paper had been included and the other analysis omitted altogether. The remaining chapters are on the whole clear and sound.

The book is well and clearly written, shows evidences of painstaking care to avoid errors and slovenly statement, and contains a fairly complete exposition of modern methods of design, although it still leaves open the field for a book which shall give practical methods of design, with the theories on which these methods are based made subordinate.

CONSTRUCTION UND PRÜFUNG DER ELEKTRICITÄTZÄHLER. By A. Königswerther. Hanover: Gebrüde Jänecke. 328 pages, 362 illustrations. Price, 9 marks.

This volume on the construction and testing of "recording" or electricity meters shows internal evidence of careful thought and thorough preparation, and is far removed from the catalogue compilation books that unfortunately form the major portion of the meagre literature on this important subject. A brief but meaty introductory chapter points out by simple mathematical analysis the principles on which all integrating meters must be based, the categories into which the different types must fall, and the various schemes of connection and combinations required for the measurement of energy in polyphase circuits. This is followed by a long second section extending over two hundred odd pages on the constructive details of representative instruments of each class. The classification is in itself good, being as follows: Registering instruments, i. e., true recorders making records on charts; instruments making periodic summations; true integrating meters; meters for special work such as those indicating the amount of charge left at any time in accumulators; and constructive details.

The true integrating instruments are subdivided as follows: Electrochemical class, pendulum class, motor class, induction class, oscillating class, time integrators showing the length of time that current has been consumed in a given circuit, but not the energy integral; and special types like the thermal, electro-pneumatic and others which are interesting but have not come into practical use.

The third and last section treats of testing electricity meters. In this the author has unfortunately found it necessary to confine himself to the types in common use in Germany and Austria, but much that is said is naturally applicable to our American meters as well; and the numerous specimen test record sheets, while calling in most cases for a thoroughness of investigation and tabulation that is foreign to our ordinary practice, will be found by those who, whether as makers or operators, have to do with meters in large numbers, to contain useful hints.

Some of the instruments described, notably the Aron pendulum meters, the oscillating meters whose moving element oscillates instead of rotates, and the time counters, are of a class which, while popular abroad, are not found in service here, but the volume cannot be said to suffer in interest for that reason. The chapter on constructive details is not as full as might be desired, and there are a few, but only a very few, of the minor inaccuracies that inevitably creep in in works of such scope.

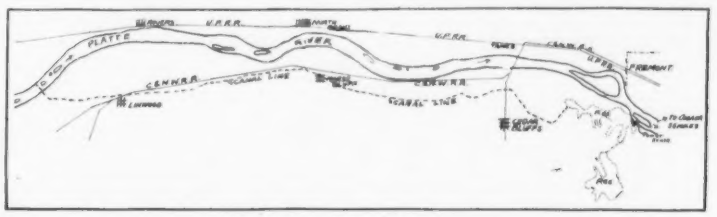
All in all, the volume is a distinctly valuable contribution to the art, and it is to be hoped that a good English translation will soon make its contents available to the many to whom it will be of interest.

Important Nebraskan Hydraulic Power Project.

A board of arbitrators, consisting of T. W. Kloman, of the John F. Kelly Engineering Company, New York, and George H. Kimball, formerly chief engineer of the Lake Shore, Michigan & Southern Railroad, appointed recently by the Fremont Canal & Power Company, of Fremont, Neb., and the Nebraska Central Irrigation Company, of Columbus, Neb., which companies were organized for the purpose of developing water power for lighting, traction and general purposes in Omaha and other adjacent cities, to decide as to which scheme was the more practicable, met in New York last week and made an award in favor of the Fremont proposition.

The Fremont Canal & Power Company is incorporated under the laws of the State of Nebraska with a capital of $4,000,000. The president of the company is W. J. C. Kenyon, general manager of the Union Stockyards, at South Omaha. L. D. Richards, a Fremont banker, is also largely interested in the enterprise. Construction work will be begun in the early spring. The contract has been let to the John F. Kelly Engineering Company, New York. The power will be used in Omaha chiefly. Other places to be supplied include Lincoln, Council Bluffs, Fremont and Columbus. The plant will have a 24-hour capacity of 15,000 hp.

It is proposed to build a diverting weir, using the entire crest for a spillway, across the Platte River, which will raise the water about two feet above its normal height, or to an elevation of 1,335 ft., United States geological survey datum. The site selected for the location of the diverting weir and headgates is about 13 miles east of Columbus, the confluence of the Loup and Platte Rivers. The dam will be a rock-filled pile dam protected by a double row of sheet piling on both the upper and down-stream forces. The headgates will consist of 20 openings 8 ft. by 6 ft. 6 in. wide, a heavy plank floor 30 ft. wide, and a pile rock-filled crib 10 ft. by 4 ft. 8 in., between each opening. The elevation at the top of the headgates will be sufficiently high to guard against floodwater. After leaving the headgates the canal is to follow an easterly course across the bottom lands of the Platte for a little more than a mile to a range of



MAP OF ROUTE OF CANAL.

low foothills having an elevation of about 20 ft. above the Platte Valley.

At Morse Bluff the level of the canal will reach an elevation of about 60 ft. above the Platte River, and at this point the higher foothills or bluffs turn sharply to the south. From Morse Bluff to Cedar Bluff, a distance of 9 miles, the canal is to be located mainly either near the top or on the top of the first bench above the valley. This bench has an elevation of from 50 to 75 ft. above the Platte Valley. At the twenty-second mile the canal is to turn to the south and to flow along the foothills for about two mlies, when it will turn sharply again to the north and cross the low foothills, which divide the Silver Creek watershed from the watershed of Elm Creek, and terminate on a large reservoir to be built at Elm Creek. The canal will be 25 miles long. Especial attention is to be paid to securing the most direct alignment possible. At the headgates the level of the bottom of the canal will be the same as the level of the bottom of the Platte River. This will give a water depth of six feet in the canal at this point.

In excavation the practice in Nebraska is to cut the slopes nearly vertical in order to keep as much water off them as possible. In order to keep the water from slopes, a thorough system of ditches will be cut on the uphill side, well back from the top of the slope. On sidehill work it has been endeavored to keep the section of the low side of the canal in at least six feet of cutting.

Evaporation in the vicinity where the canal is to be built is about 40 in. annually. This amount for the area of the canal and reservoir gives 24 c.f.s. loss. Running along the foothills as the line of the canal will do, nearly all the water courses will be crossed at right angles. The larger of these water courses it is proposed to take under the canal by means of iron pipe culverts. At the smaller water courses and where the bottom of the draws crossed are below the grade of the bottom of the canal, it is proposed to lead these water courses directly into the canal. The Elm Creek reservoir is to be formed by building a dam across the mouth of Elm Creek near the point where it empties into the south branch of the Platte River. This will give a head of 125 ft. and will impound 870 acres. A draw-off culvert is to be built through the bottom of the canal and on the east side through a section of the concrete core wall. The penstocks are to be placed at such an elevation as will enable 21 ft. in the depth of the reservoir to be used. A masonry spillway is to be constructed

about three-quarters of a mile west of the dam site, diverting the flood water back into the Platte River. Separated from the Elm Creek watershed by a ridge whose highest elevation is 1,365 ft., is the Pocoho watershed. A dam is to be built on this watershed. It will be about 70 ft. high and 3,100 ft. long and will impound 1,200 acres. The Pocoho watershed is very small and this reservoir is to be supplied through a canal cut between it and the Elm Creek reservoir, the level of the bottom of the canal to be such as will enable 21 ft. of this reservoir to be drawn from. The canal is calculated to deliver to the reservoir 1,600 c.f.s. This amount of water acting under a head of 125 ft. rating the water wheels at 80 per cent. efficiency will give at the wheel 18,160 24-hour hp, or 36,320 12-hour hp. Taking into account the losses in generators, transformers and line, the engineers expect to be able to deliver 14,620 24-hour hp, or 29,240 12-hour hp at Omaha.

The power house is to be located on the plateau about 400 ft. east of Elm Creek on the south bank of the south branch of the Platte River. The hydraulic installation will consist of eight 6,000-hp units. Each unit will consist of two water wheels coupled to the same shaft and running at a speed of 400 r.p.m. The penstocks are to lead directly from a concrete forebay in the Elm Creek dam and are to be 8 ft. 6 in. in diameter. The velocity of the water at full gate during times of overload will be about 10 ft. per second. Draught tubes will be used discharging directly into a concrete tailrace to be built underneath the power house. This tailrace will discharge directly into the south branch of the Platte River, whose channel will be cut back to the face of the power house.

The electrical installation will comprise eight 3,200-kw, 60-cycle generators having an overload capacity of 25 per cent., coupled directly to the water wheel shafts by means of a flexible coupling. The initial installation provides for six of these machines, one of which will be held in reserve. These five generators will have a capacity of 16,000 kw, which at times of overload can be increased to 20,000 kw. The generators are to be connected to step-up transformers raising the voltage to about 40,000 volts. This line voltage is to be again reduced at Omaha, 32 miles distant, to correspond with the voltage used in the city service. The pole line will be a double one, carried on a private right of way, and is calculated for a line loss of 7½ per cent. Two switching stations are to be installed between the power house and the sub-stations at Omaha.

The entire system is expected to be in active operation inside of two years. It will entail an expenditure of about $3,500,000.

Electric Sign Progress.

The Federal Electric Company's new porcelainized steel, sectional, lamp letter sign is the result of much study and experience, having been designed by central station men. This new sign is made up of standard size plates, each bearing a single white letter on a royal blue background, with the lamp sockets arranged in the outline of the letter. The accompanying cut of a "Drugs" sign shows the idea. The plates making up the complete sign are securely screwed to a frame of galvanized channel iron, making the construction practically water and fire-proof. The cuts show a single letter "N" ready to put on the frame, and a back view of a plate wired ready to put into place. The enameling of the plates is done at such a high temperature that, when finished, the enamel is practically gloss fused into steel. This process assures an ineffaceable color and finish. That part of the plate bearing the letter is raised about two inches above the other portion. An ornamented border gives a finished appearance to the sign. The most popular method of hanging, as shown in the cut, is to use galvanized chain and turnbuskles with ornamental wall brackets.

FIG. 2.—LETTER "N" PLATE.

The attractive features to central station men lie in the fact that when a sign is turned back to them the plates may be taken off and that they can be used in making up other signs. This is a cheap operation and reduces the chance of loss due to unproductive stock on hand, to a minimum.

A great many of these signs have made their appearance in Chicago this fall and are rapidly pushing their way into other cities. The writer passed through the shops of the company, at 76 Market Street, Chicago, a few days ago, and watched the simple work of construction and testing with a great deal of interest. Each sign is inspected by the city authorities and assembled to fit the requirements of the Board of Fire Underwriters.

FIG. 1.—ELECTRIC SIGN.

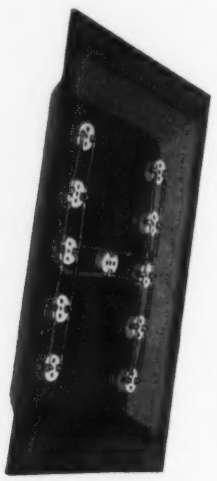


FIG. 3.—METHOD OF HANGING.

Floor Out et Box.

In modern electrical construction work there is a growing tendency to place electric light, telephone and bell wires in iron conduit, and the need of first-class floor outlet boxes for such work has long been felt. The engineers of the General Incandescent Arc Light Company long since designed and patented a universal, interchangeable floor outlet box, at all times water-tight whether in use or not. The company has still further improved its standard floor outlet box by having all parts stamped and drawn, thus insuring a perfect fit, reducing the weight, and lessening the cost of production. This box has been approved by the National Board of Fire Underwriters.

The lower body of the outlet box, Figs. 1 and 2, is drawn from ⅛-in. cold rolled steel of the best grade, in one piece. The collar is also made of the same material in one piece. The threaded portion is arranged to give an adjustment of one inch, as shown in Fig. 1, so that the depth of the box may be lengthened from four inches to five inches, and remain perfectly level after once being set in position. The top plate is made of heavy brass. It is fastened to the iron collar, a rubber gasket being placed between, which insures a water-tight connection. The exposed portion has a polished brass finish, and the steel body is heavily japanned, inside and out.

This floor outlet box is especially adaptable in construction work for bringing wires to floor outlet boxes for connecting electric lights, electric fans, push buttons or telephones located on tables, desks, counters or show cases, as will be readily observed by referring to Fig. 2.

FIG. 1.—FLOOR OUTLET BOX.

Among its special features which will be appreciated by engineers and construction men are that it is strong and substantial, it will not sink in the floor when subjected to heavy weight; adjustability with respect to floor level, saving wiremen's time; adjustment can be made after a floor is laid, and it is accessible after being installed, the parts being held together by standard machine screws; it is not liable to injury for the reason that the flexible cord comes from the side of the outlet nozzle, where it cannot be stepped on and the insulation crushed or injured; it is not necessary to detach cord when floors are swept or scrubbed, and the boxes can be installed cheaply because the lower stamped body is set in the building before the floor is laid.

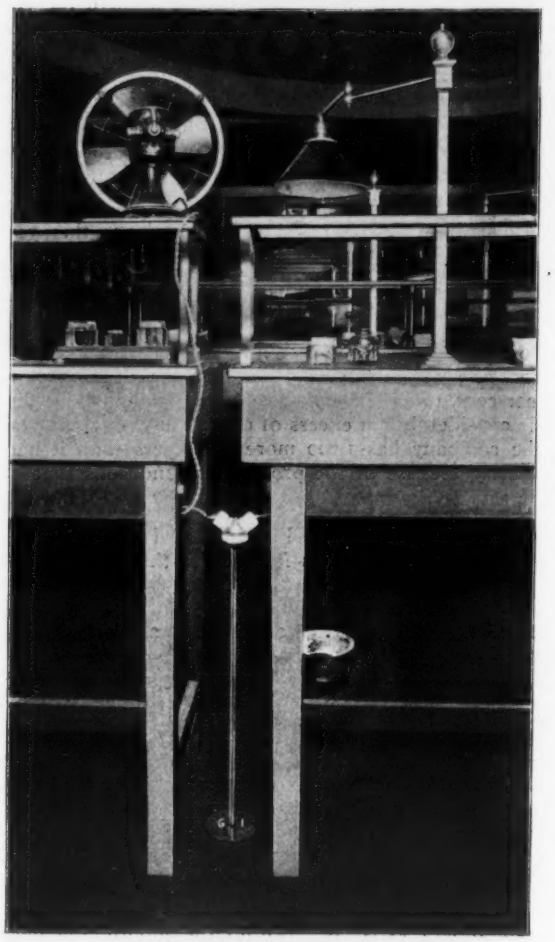
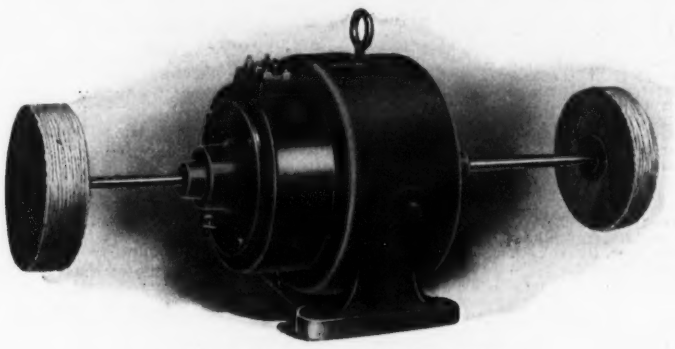


FIG. 2.—OUTLET BOX IN USE.

If it is desired not to use cords from the nozzle at floor level, one-half-in. plain iron conduit, or conduit encased in polished brass tubing, can be screwed into the ½-in. gas pipe thread in the floor plate and extended to the under side of a desk, table, counter or showcase. When placed between two or more desks or tables, as shown in Fig. 2, a two, three or four-outlet cluster can be attached to the pipe extension and connected by two or more flexible cords and attachment plugs for operating electric fans or lights on two or more desks.

Polishing and Grinding Motors.

In a great variety of industries small motors are now needed for buffing, polishing and grinding purposes, and manufacturers of silver, copper, brass and other metal wares are continually making new demands for apparatus of this character. We illustrate herewith the neat and handy appliances put on the market by the Connecticut Dynamo & Motor Company, of 526-530 West Twenty-fifth Street, New York City. As will be noted, the motors are of compact form, with unusually long shafts, which allow large and irregularly shaped pieces to be polished easily. The motors are of the bipolar type and are completely enclosed, dust and moisture-proof. The armature, field coils and working parts are completely protected from dust, moisture and other foreign substances. The armature cores are built up of laminated sheet-iron stampings mounted directly on the shaft. The winding is carefully insulated from the core, and every precaution is taken to have the insulation resistance between windings and



POLISHING AND GRINDING MOTOR.

core a maximum. The shaft projects considerably beyond the bearings and the wheels are mounted directly on the shaft. For special requirements, extra shaft extensions are provided.

Each polishing motor shaft is made with a taper thread at both ends on which the buffing wheels are mounted; and each grinding motor has its extension shaft at each end fitted with check plates and clamp nuts. All the motors are supplied with automatic starting boxes, having "no-voltage" release. The motors can be had with a floor column of hollow iron casting and a cast-iron drip pan, the starting rheostat and all electrical connections being mounted inside the column, which has a door.

Large Mexican Contract for Centrifugal Pumps.

The International Steam Pump Company has just been awarded the largest contract ever placed for high-lift centrifugal pumps. The contract calls for eleven machines to be electrically operated. They will be installed in Mexican mines for drainage purposes.

Pumps of this class consist, roughly speaking, of a paddle wheel or impeller revolving at high speed in a suitable casing, the water entering at the axis and being expelled by centrifugal force at the periphery. Heretofore, however, such pumps have been used for heads of only 10 to 20 feet. The pumps now ordered will have heads ranging from 85 to 560 ft., and their capacities are to vary from 100 to 1,500 gallons per minute. The direct-connected motors will be built by the General Electric Company. They will be of various sizes up to 200 hp. The Brooklyn plant of the Henry R. Worthington branch of the International Company will manufacture the pumps. It is interesting to note that Mexico makes a continual demand on this country for hydraulic apparatus.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Although there was a firm tone in speculation, quietness prevailed. The standard railway stocks, together with such specialties as Brooklyn Rapid Transit and Amalgamated Copper, continued to be the chief objects of attention. United States Steel was also prominent, and advanced on the short interest in it on the news that the prices of steel products were to be maintained by the pool. The money market is easier, and on the whole the general situation is favorable. While Brooklyn Rapid Transit was conspicuous it failed to regain much of the decline it suffered during the previous week. The sales amounted to 133,500 shares, at prices ranging between 48¼ and 51⅜, the closing quotation being 50—a net gain of 1⅞ points. Met. St. Ry. did not figure to much extent in the dealings, only 6,700 shares having changed hands between 121 and 122¾, the closing figure being 121¾, a gain of ½. General Electric made a gain of 1½, closing at 165½, ex div., and was quite steady throughout the week. Westinghouse Com. closed at the highest price of the week—158⅜, which is a net gain of 6⅜ points. Western Union closed at 86 ex div. American Dist. Tel. and Ameri. Tel. & Tel. are both lower, the closing rates being 24½ and 125, respectively. Following are the closing quotations of December 21:

NEW YORK.

	Dec. 15	Dec. 21		Dec. 15	Dec. 21
American Tel. & Cable	80	80	General Electric	164	164
American Tel. & Tel.	125	125¾	Hudson River Tel.	..	..
American Dist. Tel	23	24	Metropolitan St. Ry.	121¼	122¼
Brooklyn Rapid Transit	49⅝	50⅜	N. E. Elec. Veh. Trns.	..	..
Commercial Cable.	..	..	N. Y. & N. J. Tel.	..	..
Electric Boat	*23	15	Marconi Tel.	..	..
Electric Boat pfd.	48	40	Western Union Tel.	..	..
Electric Lead Reduction.	⅝	⅝	Westinghouse com.	155½	157
Electric Vehicle	5¾	5¾	Westinghouse pfd.	185	180
Electric Vehicle pfd.	8	8			

BOSTON.

	Dec. 15	Dec. 21		Dec. 15	Dec. 21
American Tel. & Tel	125¾	125¼	Western Tel. & Tel. pfd.	79¼	*81
Cumberland Telephone	*115	*115	Mexican Telephone	1⅛	1⅛
Edison Elec. Illum.	231	220	New England Telephone	122	122
General Electric	163	165	Mass. Elec. Ry.	18½	18
Western Tel. & Tel	7⅛	7⅛	Mass. Elec. Ry. pfd.	76	75

PHILADELPHIA.

	Dec. 15	Dec. 21		Dec. 15	Dec. 21
American Railways	42½	43	Phila. Traction	..	..
Elec. Storage Battery	53	54	Phila. Electric	6⅛	6
Elec. Storage Battery pfd.	53	54	Phila. Rapid Trans.	10⅛	9¾
Elec. Co. of America.	8	8			

CHICAGO.

	Dec. 15	Dec. 21		Dec. 15	Dec. 21
Central Union Tel.	..	..	National Carbon pfd.	90	92
Chicago Edison	..	..	Metropolitan Elev. com.	16	16
Chicago City Ry	159¼	160	Union Traction	6	5⅛
Chicago Tel. Co	..	..	Union Traction pfd.	25	25⅛
National Carbon	20	20			

*Asked

MASSACHUSETTS ELECTRIC.—The Massachusetts Electric Companies has issued its fourth annual report, showing gross $6,333,910, net $2,178,002, and dividends of $840,232, with $1,331,147 charges, leaving a surplus of $6,623. President Gordon Abbott says: "As a result of the considerable amount of new construction done in 1902 for the purpose of connecting various existing lines, little work of that kind has been done during the past year, but very important improvements have been carried out both to the equipment and to the power houses. Thus during the fiscal year the following amounts have been expended: Cars and electrical equipment, $906,000; reconstruction of track, $468,000; power stations, $910,000; reconstruction of cars, $93,000; land, buildings and engineering, $193,000; total, $2,570,000; spent for new roadway and new tracks, $460,000. During the year 164 new cars were purchased, of which 132 were equipped, 25.5 miles of track were reconstructed with new and heavy rail, 44.8 miles of new feed wire and 2½ miles of underground feeder were built and 8,500 hp new machinery installed. Besides this the new station at Newport, with 2,100 hp of turbine generators was practically completed and the new station at Quincy Point, with room for 15,000 hp of turbine generators, was pushed forward rapidly, so that it may be expected to be ready for its electrical equipment by February 1. The sum of $145,000 has been written off to cover the release of a considerable amount of old and ineffective machinery made necessary by the new improvements. Since your trustees accepted the trust four years and a half ago, the records show that during that period, and leaving out of account all new construction, 75 miles of track have been reconstructed with either 75-pound tee or 90-pound girder rail—267 miles of new feeder wire have been strung—123 cars reconstructed and increased in size and 621 cars and snow plows added, and 1,064 new motors and equipments purchased."

CHICAGO ELEVATED LINES MAKE GAINS.—The South Side, the Northwestern and the Metropolitan Railway Companies have issued November traffic reports, and all make excellent showings. In point of gains, the Alley "L" leads the list. A considerable percentage of the increase is directly attributable to the strike on the surface lines, which diverted traffic to the Alley "L" during the last two weeks in the month. From November 12 to November 25, inclusive, the average daily traffic was 206,000. This exceeded by 10 per cent. any like period during 1893, the World's Fair year. The banner day for the month was November 14, when 229,535 passengers were carried. The Northwestern Elevated made the second best showing for the month, a daily average of 71,422 passengers, as compared with 67,236 during November of last year, an increase of 6.23 per cent. In the case of the Metropolitan Elevated, the daily average for the month showed an increase of 3.5 per cent., as compared with the corresponding period of last year. The daily average this year was 114,148 passengers, as against 110,189 the previous year.

DIVIDENDS.—The regular quarterly dividend of 1¾ per cent. on the stock of the New York Metropolitan Street Railway Company will be paid January. 15. The directors of the American Telephone & Telegraph Company have declared a regular quarterly dividend of 1½ per cent., and an extra of ¾ per cent., payable January 15. In accordance with the provisions of the lease of the West End Street Railway Company to the Boston Elevated Railway Company, a semi-annual dividend rental of $2 per share will be paid on West End Street Railway Company preferred stock January 1. Electric Storage Battery directors have declared a regular quarterly dividend of 1¼ per cent. on the capital stock, payable January 2. A dividend of 75c. per share has been declared on Reading Traction, payable to stock of record on December 19. The St. Joseph Railway, Light, Heat & Power Company has declared the regular quarterly dividend of 1¼ per cent. on its preferred stock.

CRANE CHRISTMAS CASH.—The Crane Company, of Chicago, will distribute $250,000 among its employes this year. The money will be divided before Christmas Day among 5,000 persons. All the men and women who have been laid off in the course of the year, whether in the company's employ now or not, will be remembered. There are about 500 of these, many of whom are now at work for other establishments. The money will be distributed on the ratio of time worked during the year. Last year Mr. Crane gave each employee 5 per cent. of his yearly wage. The amount to be distributed this year is considerably in excess of that of any previous year, partly because the company has 1,000 more employees than it had a year ago, and partly because of the prosperous conditions that have prevailed.

CONN. RAILWAY & LIGHTING.—The Connecticut Railway & Lighting Company reports as follows for the year ended June 30, 1903:

	1903.	1902.	Changes	
Gross	$1,048,259	$1,106,868	Dec.	$58,609
Expenses	819,091	668,454	Inc.	150,637
Net	$229,168	$438,414	Dec.	$209,246
Other income	180,374	167,953	Inc.	12,421
Total income	$409,542	$606,367	Dec.	$196,825
Charges, taxes, etc.	527,905	518,553	Inc.	9,352
Deficit	$118,363	Sur.$87,814	Inc.	$206,177

CHICAGO AUTOMATIC TELEPHONE.—The Automatic Telephone Company, controlled by the same interests which will operate the Illinois Tunnel Company, is to be pushed ahead as swiftly as new capital will assist it. Within the month, the officials say, the capital stock is to be increased from $3,000,000 to $5,000,000. All the new stock has been subscribed for and none will be offered in open market.

BOSTON EDISON INCREASE.—The stockholders of the Edison Electric Illuminating Company, of Boston, at a special meeting, have voted to increase the capital stock to 104,491 shares by issuing 9,500 additional shares at $200 a share, as authorized by the Gas Commissioners. The company's business grows so rapidly as to need about ten per cent. new money added to its capital every year, to provide new plant and general equipment. The price is $200 per share.

Commercial Intelligence.

THE WEEK IN TRADE.—According to reports received by the mercantile agencies, holiday and retail business is seasonably active; wholesale and jobbing trade is correspondingly quiet, and manufacturing industry is slack. Several encouraging features are noted. There is no car conjestion this year to hamper the operations of the railroads, which are handling the current excellent business offered with profitable results, as demonstrated by the fact that the gross earnings for the first half of December will probably show an aggregate gain of about 6 per cent, as compared with an increase of 4 per cent. in November. It is particularly noteworthy that these advances follow heavy gains in corresponding periods for the past eight years. Clearings show contractions at most leading centres, and failures are about normal in number. "The export trade of the country is finishing better than the earlier outlook indicated," says *Bradstreet's*, "owing to the large exports of cotton. November's export trade was the second largest month's total on record; that for eleven months exceeds a year ago by nearly $100,000,000, and points to an aggregate of exports not far from $1,458,000,000. With imports of about $1,000,000,000, the year's total foreign trade will far exceed any previous year. The reciprocity treaty with Cuba bids fair to give American cotton manufacturers an outlet not previously had for nearly $6,000,000 of goods." The iron trade is still optimistic, and makers of finished products are apparently firm in their views and prices. Machinery manufacturing is dull in the East. The metals are all strong, and building material is quite active, and is likely to so continue into the spring, judging from permits issued at leading cities. Increased expenditures for public improvements next year give hope of great engineering activity, and of large consumption of iron, steel, lumber, wire and other material. In copper there was a slight activity on export account, but later it quieted down. Purchases for home consumption were not many or large. The closing official prices were: Lake, 12⅜@12⅝c.; electrolytic, 12¼@12½c., and casting stock 12⅛@12¼c. The business failures for the week ending December 17, according to *Bradstreet's* compilation, aggregated 239, against 241 the week previous and 225 the corresponding week last year.

POWER IN BALTIMORE, MD.—It is stated from Baltimore, Md., that the completion of the great project for the electrical development of the falls of the Susquehanna River, on the Niagara plan, is now assured by the fact that Anthony N. Brady, of New York, and associates have taken over $1,000,000 stock in the United Electric & Power Company, of Baltimore, controlling the lighting of that city. Plans for the power plant at Conowingo, on the Susquehanna, have been completed, and routes for the cables to Baltimore, Havre de Grace, Elkton and other towns in Maryland, Southern Pennsylvania and Delaware have been laid out. There will be a number of changes in the directorate of the United Electric Light & Power Company by January 1. The new interests in the company have tendered the presidency to S. Davies Warfield, president of the Continental Trust Company, who conducted the negotiations with Mr. Brady. There are now five vacancies in the board of directors, and Mr. Brady, with three of his associates, will fill four of these. Mr. Brady will also become a member of the executive committee of the company, which will be increased from five to seven members. The present executive committee is composed of S. Davies Warfield, William T. Dixon, Thomas J. Hayward and Francis E. Waters. The dissolution of the syndicate holding the $2,000,000 common stock of United Electric Light & Power Company, and owning the Mount Washington Electric Light & Power Company, will mean a distribution of these securities to the new owners. The investment of the New York interests in the Susquehanna project will probably be $10,000,000. It is proposed the works can be completed in 1905 to supply 40,000 hp to Baltimore.

SOME C. & C. ORDERS.—The C. & C. Electric Company, 143 Liberty Street, New York, has taken a contract for a 75-kw, belted generator and 75-hp of motors, five in number, and varying in capacity from 5 hp to 35 hp, for installation in the Britton Leather Company tanneries, now under construction at Brewer, Me. A 30-kw, direct-connected generator has been ordered by the A. D. Granger Company, White Building, for the new Healy Building. The Illinois Southern Railway Company has requisitioned for a 25-kw generator and 25-hp of motors, for use in its Sparta (Ill.) shops. This order is a duplicate of the one received by the C. & C. people for the Chicago shops of the company. The engine will be shipped by A. L. Ide & Sons, of Springfield, Ill. The Fifth Avenue Estates will be supplied with eight slow-speed, C. & C. motors, varying from 2 hp to 15 hp, used for driving Sturtevant & Blackman ventilators in a new office building. A 75-kw, belted generator is to be used for lighting a manufacturing building now under construction in Brooklyn by Charles E. Ring, 38 South Eighth Street. Charles Wagner, 587 Hudson Street, New York, has ordered seven 5-hp, slow-speed motors for driving printing presses. A. & F. Brown Company's plant at Elizabethport, N. J., is to have further C. & C. equipment, a 100-kw, belted generator and switchboard having just been ordered for lighting and power purposes. The C. & C. Company reports that the demand for motors to be installed in small manufacturing plants in New York is picking up very materially after a lengthy stretch of dullness. A large number of orders have laready been secured and several more are expected to be closed shortly after the holidays.

ELECTRICAL INSURANCE.—With regard to the recent meeting of the electrical committee of the Underwriters' National Electric Association, Mr. C. M. Goddard informs us officially that very little was done in the way of tinkering with the code. "The most important feature which came up at this meeting was the report of the committee on standardization of enclosed fuse cut-outs. That committee reported that they had been able, through consultation with the manufacturers, to obtain an arrangement by which the different makes of such fuses shall be interchangeable, and not only that, but arranged so that it would be impossible to put a 200-amp. fuse in a 50-amp. cut-out block. There was also a report of progress from the committee on requirements relative to wiring of electric railway cars, which would indicate that through the conferences being held with a committee appointed by the American Street Railway Association, some satisfactory agreement between the parties in interest on this subject will soon be arrived at."

NEW YORK TROLLEY MATERIAL.—The Metropolitan Street Railway interests are proposing to change over to electricity next year some forty miles of horse-car line still remaining. This will require considerable new material and plant of all kinds. Mr. Paul D. Cravath, of counsel for the railway company, has sent a letter to the Mayor, in which he says that the company presents the option of having the present horse-car line in West Street continued, or else having the overhead trolley system installed, as an underground system in the street named is out of the question. He also says the road now merely is getting the view of property owners, and has made no formal application for the right to install the overhead or any other new system.

THE INTERNATIONAL TELEPHONE MFG. CO., Chicago, has, during the last few months, greatly enlarged its manufacturing plant, and completed a set of special tools and machinery for manufacturing directly from the crude material a new and improved generator-call, self-restoring drop switchboard system. It began making shipmentof this class of equipment about 60 days ago, and states that it has received, within the past month, orders for seventeen complete exchange equipments, aggregating over 4,000 lines. This, in connection with an increased demand for its long-distance country party line and village exchange telephones, has increased its business over 500 per cent.

GENERAL ELECTRIC.—An officer of the General Electric Company is quoted as saying: "The falling off in the business of the General Electric Company, such as it has been, is due to the general depression in business. We expect, however, to make for the year ending January 31 nearly as good a showing as we did last year. About six weeks ago we were about $100,00 ahead in our sales as against the previous year. The indications seem to be that for the completed year our gross receipts will be nearly as large as in 1902, and that, owing to the falling off in the price of some materials, such for instance, as copper, we shall come out very well in our net."

EXTENSIONS AT STILLWATER, MINN.—Plans and specifications are being prepared for improvements to be made to the plant of the Stillwater Gas & Electric Light Company. There is proposed a water power development of 1,000 hp, rebuilding gas works, ten miles of transmission circuits, 20-ft. dam, etc. George Mayer is secretary, and R. S. Fuertado, general superintendent, Tribune Building, Chicago, will be in charge of construction.

EQUIPMENT FOR INDIANA TRACTION.—The power house of the Northern Traction Company of Indiana, for the construction of whose system between Wabash and Marion J. G. White & Company have the contract, will be installed with two Bullock generators of 200-kw capacity each, direct-connected to Allis engines of 250 hp. Two 100-kw Bullock compound boosters, to be wound for 550 volts, have also been ordered.

BOILERS WANTED.—The Board of Water Commissioners of Dunkirk, N. Y., will on January 14, at 8 P.M., open sealed proposals for two 150-hp boilers. Bids will be received on either water-tube or return tubulars, and with or without stokers. Bids can be filed up to the hour of the meeting. Specifications and other information will be furnished by Mr. W. C. Baumgartner, the secretary of the Board.

KILBOURNE & CLARK COMPANY, Seattle, Wash., has received a contract for an electric lighting plant which is to be installed at Leavenworth, Wash.

BALL ENGINE COMPANY.—Erie, Pa., has recently sold an automatic engine to the village of Chardon, Ohio, for electric lighting purposes.

General News.

THE TELEPHONE.

PRESCOTT, ARIZ.—Yavapai County, which is nearly as large as the State of Indiana, is supplied with telephone service by the Prescott Electric Company, 450 subscribers at Prescott and 90 at Jerome. The company furnishes toll service to all the principal mining camps.

LITTLE ROCK, ARK.—The North Arkansas, Southwest & Missouri Telephone Company has been organized here with W. T. Stahl as president.

CORNING, ARK.—The opening of a line by the Corning Telephone Company to Poplar Bluff gives connection with Doniphan, Neelyville, Harville, Poplar Bluff and a number of intermediate points.

NEW LEWISVILLE, ARK.—There has been an increased demand for telephone service during the last few months made upon the Walnut Hill Telephone Company. There are 115 subscribers, and 25 miles of toll line. Another toll line will shortly be erected.

MENA, ARK.—Mr. J. M. Davis, secretary and treasurer of the Kizer Telephone Company, reports a probable increase from 275 to 400 subscribers. A Kellogg 300-drop board is operated, and there are about 150 miles of toll line. A minimum charge of 25c. is made for toll service.

ARKADELPHIA, ARK.—The Arkadelphia Telephone Company is at present leasing its equipment from the Southwestern Telephone & Telegraph Company, but it is planned to put in an independent exchange. The company has 180 subscribers, 175 miles of toll line, and contemplates building 25 more miles.

LITTLE ROCK, ARK.—The North Arkansas, South Missouri & Indian Territory Telephone Company has been organized with the following officers: President, W. T. Stahl, Siloam Springs; vice-president, W. T. McCormick, Prairie Grove; secretary, K. G. Comfort, Westville, I. T.; treasurer, H. O. Beeson, Pipeville, Mo.

DENVER, COL.—The Colorado Telephone Company has recently inaugurated a system whereby ranchmen and residents of 238 Colorado towns are notified every morning of the weather conditions and probabilities. This will be a safeguard to the farmers in taking care of their vines and fruit trees when a storm is threatened. Seventeen towns in New Mexico are receiving a similar service.

SHARON, CONN.—The Sharon Telephone Company has 210 subscribers who pay $16 for residence and $18 per annum for business service. "American" apparatus is used. About twenty subscribers have recently been acquired.

GAINSBORO, GA.—The Gainsboro Telephone Company, a long-distance concern with headquarters at Carrollton, Ga., has bought the plant of the Hogansville, Ga., company and several short lines, valued at about $2500.

SAYBROOK, ILL.—The Arrowsmith Telephone Company has been incorporated with a capital stock of $1200. Directors: C. W. Hurst and others.

FLANAGAN, ILL.—The Flanagan Telephone Company has been incorporated; capital, $800. Incorporators: H. F. Mette, J. H. Linneman, D. W. Halen.

CARTHAGE, ILL.—The East Carthage Telephone Company has been incorporated. Capital, $21000. Incorporators: O. W. Cuter, C. Wright, Samuel Curry.

YORKTOWN, ILL.—The Hoopole, Yorktown, Tampico & Thomas Telephone Company has been incorporated with a capital of $4900. Directors: F. E. Toy, Wm. Thomas and Thomas Burton.

FLANAGAN, ILL.—A new Stromberg-Carlson switchboard has recently been put in at Gridley, Ill., the exchange at which place and that at Flanagan are operated by the Waldo Telephone Company, Mr. E. E. Fosdick is secretary.

METROPOLIS, ILL.—During 1903 the Metropolis Telephone Company built 25 miles of toll line and added 50 subscribers, the total now being 50 miles of toll line and 200 subscribers. A Eureka switchboard of 200 drops (150 installed) is in use at this place.

MATTHEWS, IND.—The Matthews Telephone Company has been incorporated with a capital stock of $15,000. Directors: E. W. Trook, P. E. Rudd and others.

INDIANAPOLIS, IND.—The Greene County Telephone Company has filed articles of incorporation with the Secretary of State. The capital stock is $10,000. Ziba P. East, W. H. Cooper, A. L. Milam, Wm. H. Beaty and Henry W. Moore are the officials.

INDIANAPOLIS, IND.—Arrangements have been made to enable the Indianapolis weather bureau to announce the weather forecast each day at 10 o'clock to the residents of the extreme part of northern Indiana. The plan is to telephone the report to Lagrange, Shipsewana, Millersburg and Middleburg from which centers it will be distributed to all telephone patrons at the hour named. A similar service has long been in use in central and eastern Indiana.

MUNCIE, IND.—The Merchants' Association of this city held a spirited meeting recently and voted against supporting two telephone systems, agreeing to have Central Union telephones removed from their places of business. This action was taken after a conference with the Central Union officials who promptly refused to reduce rates to equal those charged by the Delaware & Madison County Company. The fight has been on for some time. The Central Union agreed to improve the service, but this was not satisfactory, hence the action of the Merchants' Association. It is asserted that the action is the entering wedge that will practically kill the Central Union's business in Muncie.

FT. WAYNE, IND.—At the annual meeting of the Home Telephone Company of this city the following were elected directors: W. L. Moellering, C. S. Bash; L. C. Hunter, Jno. B. Reuss, G. M. Hooffman, M. B. Fisher and W. A. Bohn. The stockholders approved the plan to pay the outstanding bonds—$250,000—in twenty yearly installments and appropriated the required amount to pay the first installment. The company has no liabilities other than the bonded debt which will be all paid by 1918. It owns the two buildings in which the exchanges are located and now has 3000 telephones in use with 200 applications pending. There are 120 stockholders and the number of employees is 85.

INDIANAPOLIS, IND.—The plan to merge all the telephone companies affiliated with the Independent Telephone Association, as mapped out at the recent meeting at Chicago, is attracting general interest and comment in Indiana. Mr. Sherrin, general manager of the New Telephone Company, says that while his company was not represented at the meeting he does not understand that the merging pertains to the formation of one large company, but is a plan to bring the companies into a closer relationship with a view to perfecting and extending long-distance telephone service by some sort of reciprocal agreement. The movement, Mr. Sherrin thinks, does not contemplate the transfer of property or the show of money, but rather to form a community of interests in order to obtain better and wider service. He thinks such a plan practical, even though the various companies continue to operate separately as they are doing at the present time.

OAKVILLE, IA.—The Oakville Telephone Exchange Company has been organized.

POSTVILLE, IA.—The Farmers' Mutual Telephone Company has been organized with a capital stock of $3000. E. T. Henderson is president.

ALBERT CITY, IA.—The German-Swede Southern Telephone Company, Albert City, Ia., has recently completed a net-work of lines in that section for a rural party line telephone system. The system is constructed with lines of the most substantial character possible and is equipped throughout with long distance telephones of the "International" bridging type.

SABETHA, KAN.—The Sabetha Telephone Company has increased its capital stock from $10,000 to $30,000.

LOUISVILLE, KY.—The Central Mississippi Telephone Company has incorporated with a capital stock of $10,000. Directors: M. H. Woodward, W. C. Wright and others.

BANGOR, ME.—The Bangor Automatic Telephone Company has been incorporated with a capital stock of $250,000.

BALTIMORE, MD.—The Maryland Telegraph & Telephone Company has opened a long-distance line from Baltimore to Hagerstown, through connection with the Frederick Telephone & Telegraph Company and the United Telephone Company of Hagerstown.

PONTIAC, MICH.—The Oakland Telephone Company is now connected with Detroit. A line from Sand Hill to the Franklin road, three miles south of Pontiac has been completed by the Co-operative Telephone Company of Detroit.

HART, MICH.—The stockholders of the Oceanic Telephone Company have voted to change the name of the company to Lake Shore Telephone Company and increase the capitalization to $200,000. This action was made necessary by the purchase of the Pere Marquette Telephone Company's property in Mason County.

KALAMAZOO, MICH.—The Citizens' Telephone Company's system will be in operation in a few months. The following named officers have been elected: President, F. F. Reed; vice-president, W. W. Olin; secretary and general manager, R. C. Parkard, of Toledo; treasurer, E. W. Bowman. The company is capitalized at $250,000. It is stated it will be financed by a large eastern trust company. At the start exchanges will be opened at Galesburg, Augusta and Richland, and toll lines will be run from the rural districts to connect with the various exchanges.

NORTHFIELD, MINN.—The Northfield Telephone Exchange Company will install a central energy switchboard.

VINELAND, N. J.—The Mutual Telephone Company, of this place, has been incorporated with a capital stock of $25,000. Harry Taylor is president.

BELLEMEAD, N. J.—The Hellsborough & Montgomery Telephone Company has been incorporated with a capital stock of $125,000. Directors: P. A. Garretson, Wm. C. Hendrickson and others.

SCHENECTADY, N. Y.—The Schenectady, Delanson & Esperance Telephone Company has been incorporated with a capital stock of $1500. The directors are L. L. Terpering, J. V. Vidder and others.

COLUMBUS, N. C.—The Columbus Telephone Company has been re-organized and new officers elected. The property was recently bid in at public auction.

CLIFFDALE, N. C.—The Cliffdale Telephone Company, of Rutherford County, N. C., has been chartered by Edw. Thompson and others. Capital, $5000.

WAYNESVILLE, N. C.—It is proposed to change from magneto to central energy system within the next six months by the Waynesville Telephone Company; also to build 40 more miles of toll line. The subscription list has almost doubled recently, and now numbers 130 names. The charges are $12 to $24 per annum.

LUCAS, OHIO.—The system of the Monroe Telephone Company is maintained on the mutual plan. Of the present 150 subscribers one-third was added last year.

FAIRVIEW, OHIO.—Two Kellogg 100-drop boards are operated by the Union Telephone Company with its 100 subscribers. A probable increase of one-third is expected next year.

CLEVELAND, OHIO.—Pres. F. S. Dickson, of the United States Telephone Company, has completed plans for enlarging the scope of that company's business which call for the expenditure of $500,000 during the coming year.

PORTSMOUTH, OHIO.—Manager E. E. Knox, of the Portsmouth Telephone Company, says "Our system is growing fast; we have trouble to keep up with new business." An "American" 1000-drop is in operation, and there were 1278 subscribers on Sept. 28, 1903.

THE DALLES, ORE.—The Seufert & Condon Telephone Company which began operation in May, 1895, is believed to be the first independent system operated on the Pacific Coast. Since starting, the exchange has never closed day or night. In two months a Kellogg Express board will be installed. There are 500 subscribers. Mr. J. W. Condon, manager, tells us that they enjoy a continuous growth of substantial subscribers and do not encourage any others. Some new country lines are planned.

STROUDSBURG, PA.—The Monroe County Telephone Company was started by some farmers in this vicinity, and is controlled and operated by a portion of the Stroudsburg & Bushkill Telephone Company. A 10-line board is to be placed at Mt. Pocono as soon as possible to handle the service at that end, when more telephones will be added. The Stroudsburg exchange uses Kellogg instruments.

YANKTON, S. D.—The Sioux City Telephone Company will erect a plant here to cost $350,000.

MORRISTOWN, TENN.—The Citizens' Telephone Company has increased its capital from $7000 to $12,000.

RUSSELLVILLE, TENN.—The Russellville Telephone Company has been incorporated with a capital stock of $10,000. R. M. Drummond is president.

CHATTANOOGA, TENN.—A long-drawn fight has been ended at Chattanooga by the signing of a contract between the East Tennessee Telephone Company and the Hamilton Telephone Company in which the former agrees to maintain the rates prevailing before the recent advance, and the independent company agrees to surrender its franchise to the city and not to apply for another.

NAVASOTA, TEX.—The Southwestern Telegraph & Telephone Company is to spend something like $1,000,000 in improving and enlarging its service in Texas.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company is in a peculiar situation in this city. The council has recently passed an ordinance prohibiting any telephone company from erecting poles until a franchise has been obtained. The Bell Company is now operating here under a perpetual right, but it will be compelled, if it desires to erect any more poles, to obtain a franchise covering a limited period.

RURAL RETREAT, VA.—A small steady increase is reported by the Rural Retreat Telephone Company with its 125 subscribers and over 75 miles of toll line. Each subscriber pays $9 per annum.

TAZEWELL, VA.—The Tazewell Telephone Company, with 250 subscribers, using "Eureka" instruments, reports that it is constantly building. Mr. George W. St. Clair is secretary and treasurer.

PULASKI, VA.—Some twenty-five exchanges distributed over ten counties come within the system of the Virginia & Tennessee Telephone Company which uses Sumter apparatus for its 2500 subscribers.

FRANKLIN, VA.—There are about 70 subscribers to the system of the Virginia and Carolina Telephone Company, which reports a steady growth. The rates for service are $2 and $1.50.

GLOUCESTER, VA.—The Tidewater Telephone Company operates three exchanges, and numbers 265 subscribers. The trunks between exchanges are to be increased and two short party lines of eight or ten miles each are to be built.

MEHERRIN, VA.—The recently-organized Lunenburg Telephone Company is building lines from Meherrin to Lunenburg C. H., a distance of about 16 miles. If the line is found profitable the operations of the company will be extended.

BUCKHANNON, VA.—The Buckhannon Telephone Company has 500 subscribers. A 300-drop Eureka switchboard and a 100-drop Standard Telephone & Electric switchboard are installed. Cables for towns and toll line copper metallic circuits are projected. J. W. Downs is manager.

ALBEMARLE, VA.—The Albemarle Telephone Company, with its 675 subscribers, using Western Telephone Construction apparatus, reports that it is now on a paying basis and expects to have 1000 telephones in about a year and a half, which will mean a change from a magneto to a common battery system.

NORFOLK, VA.—The Southern States Telephone Company has just changed from the magneto to the common battery system and anticipates an increase in business as a result of the much superior service. It is planned to build a number of extension lines and cables. At Norfolk City there are 1320 patrons, where a 1680-drop Kellogg switchboard is used. The rates charged are $28 and $38 per annum.

BURNSVILLE, W. VA.—Three exchanges are operated by the Weston Central Telephone Company, which has 250 subscribers and 275 miles of toll line. The system has been installed for four years. The rates are $18 and $24.

CHARLESTON, W. VA.—The Charleston Home Telephone Company commenced operations in January, 1901, with 300 subscribers; it now has 1100. The company owns 350 miles of toll line, covering the Kanawha coal field, and connecting with the adjoining states. The demand for service is very great, and the company is growing at the rate of 30 to 50 subscribers a month. A 3000-drop Kellogg switchboard is installed here. The company expects to build 150 miles more of toll lines during the next few weeks.

READSTOWN, WIS.—The Readstown Telephone Company has been incorporated with a capital stock of $5000. The directors are F. M. Groves, C. W. Reeve and others.

BERLIN, WIS.—The Waushara Telephone Company operates a 200-drop board at Berlin, a 50-drop board at Wild Rose, and at Wautona a 50-drop board. Mr. A. F. Adams is secretary and manager.

PHOENIX, B. C.—The Vernon & Nelson Telephone Company has expended $10,000 recently in rebuilding and improving its service in this city.

ELECTRIC LIGHT AND POWER.

EUREKA, CAL.—The Humboldt Bay Lighting & Power Company has been reported incorporated, with a capital of $1,000,000, to construct a water power plant on the Klamath, capable of generating 3000-hp, and an auxiliary plant in East Eureka of 1500-hp. Incorporators: J. C. Bull, Jr., and Geo. Henderson, of Eureka; Ralph W. Bull, of Arcata, and others.

WASHINGTON, D. C.—John A. Moon has introduced in Congress a bill authorizing the city of Chattanooga, Tenn., or a private corporation, to construct a dam and locks on Tennessee River for the operation of an electric power plant which would cost several millions.

LOUISVILLE, GA.—Bids will be received Dec. 29 by L. R. Farmer, City Treasurer, for $20,000 light and water bonds.

MILLEDGEVILLE, GA.—The Oconee Electric Light & Power Company will expend at present time $225,000. The company will do its own work.

CHARLESTOWN, IND.—The Town Trustees have granted Clarence R. Hay a ten-year franchise for an electric light plant.

KEWANEE, ILL.—The Council has under consideration the establishing of a lighting plant in connection with the city water works.

SHELBYVILLE, ILL.—The Shelbyville Water, Heating & Lighting Company has been incorporated. Capital $50,000. Incorporators: W. H. Beam, Chas. C. Scovil and Wm. S. Middlesworth.

BALTIMORE, MD.—Anthony N. Brady, of New York, N. Y., and associates have taken over $1,000,000 stock in the United Electric Light & Power Company, of Baltimore, controlling the lighting of this city. Plans for the power plant at Conowingo, on the Susquehanna, have been completed, and routes for cables to Baltimore, Havre de Grace, Elkton and other towns in Maryland, Southern Pennsylvania and Deleware have been laid out.

EVELETH, MINN.—P. E. Dowling has petitioned for a franchise for an electric light plant.

MOORHEAD, MINN.—The Moorhead Electric Light & Power Company has been incorporated, with a capital of $50,000. E. E. Moore is reported interested.

LIVINGSTON, MONT.—The plant of the electric light company has been destroyed by fire, and will be rebuilt at once. C. S. Hefferlin is manager.

PENN YAN, N. Y.—A committee of the Board of Trustees is investigating the electric light question, with a view to establishing a municipal plant.

NEW YORK, N. Y.—The following bids for installation of electric wiring, fixtures, etc., for lighting the new Williamsburg Bridge, over East River, have been opened by Gustav Lindenthal, Commissioner of Bridges; J. C. Livingston, Jr., Company, $21,700; Commercial Construction Company, $18,000 and M. B. Foster Electric Company, $18,423.

GENEVA, N. Y.—The Geneva Power & Light Company has placed an order with the General Electric Company for $10,000 worth of new equipment for its plant in this city, to consist of 110 new street lamps of the enclosed type, one new 225-lamp alternating current dynamo for the street service and one smaller alternating current dynamo for incandescent service.

ULYSSES, N. Y.—The Ulysses Electric Light, Heat & Power Company has been incorporated at Albany with a capital stock of $23,000. The directors are Frederick C. Biggs and Ossian G. Noble, of Trumansburg, and Professor Gardner S. Williams, of Ithaca. The company purposes to erect a power house on the banks of Taughannock creek, and to operate it by water power. Work on the plant has already been begun.

BURLINGTON, N. C.—The Robinson-Humphrey Company, of Atlanta, Ga., has bought $30,000 bonds of the town of Burlington, the proceeds of which will be used for an electric lighting plant.

HENDERSONVILLE, N. C.—The Hendersonville Light & Power Company, of Hendersonville, has been incorporated with a capital of $50,000. R. M. Oates, M. D. Peden and C. H. Oates are the incorporators.

MECHANICSBURG, OHIO.—D. J. Long has secured a franchise for an electric light plant.

HAMILTON, OHIO.—The Hamilton Heating & Power Company has been incorporated by Peter Bisdorf, Ed. C. Sohngen, Fred. Schwenn, and others, with a capital of $10,000.

WILMINGTON, OHIO.—The Wilmington Water & Light Company has been incorporated with a capital of $125,000.

HELLERTOWN, PA.—The question of constructing a municipal electric light plant is under consideration here.

JOHNSTOWN, PA.—The shareholders of the Citizens' Light, Heat & Power Company have approved the proposition to increase the capital from $250,000 to $1,000,000. The purpose of the increase is to effect a consolidation of its interests with those of the Johnstown Light, Heat & Power Company.

COLUMBIA, S. C.—A controlling interest in the Columbia Electric Railway, Light & Power Company has been secured by Edwin W. Robertson and associates. The deal includes the electric lighting plant of the city.

JEFFERSON CITY, TENN.—G. A. Moody, an attorney of Jefferson City, has secured a second franchise for a lighting plant in this city. Another plant is now in operation.

ELMA, WASH.—It is stated that the White Star Milling Company will install an electric light plant of 2000 lights capacity.

BALLARD, WASH.—A. Starkey has petitioned City Council for a franchise for an electric light plant. He proposes constructing a plant to cost about $80,000.

DAUPHIN, MAN.—Applications are wanted for franchises and proposals for the installation of electric light plant and telephone system. Wm. Rintone is city clerk.

THE ELECTRIC RAILWAY.

CHICAGO, ILL.—The principal offices of the Los Angeles Traction Company have been changed from Jacksonville to Chicago.

CHICAGO, ILL.—A new traction company, the South Side Suburban Railway Company, has petitioned the Chicago council for a 20-year franchise for a double or single track road to tap the following districts: Pullman, West Pullman, Dolton, Hammond, Harvey and Chicago Heights. No compensation was mentioned, and the petition has been referred, together with frontage consents, to the committee on local transportation. The northern terminus will be at the State Street line of the Chicago City Railway Company. C. C. Heisen is president. Stephen A. Foster, vice-president, and Cornelius J. Ton, secretary.

EVANSVILLE, IND.—It is authoritatively announced that the Evansville & Newburg suburban line will be changed from a steam to an electric road, and that it will be extended to Rockville via Boonville.

PORTLAND, IND.—The Eastern Indiana Traction Company, which is to build through Portland, has let the contract for the building of its grade between Richmond and Fountain City. Work on that end of the line will begin at once. The company laid several hundred feet of track in Richmond some time ago in order to hold its franchise.

MUSCATINE, IA.—The car house of the Citizens' Railway & Light Company, with 27 cars, was burned Dec. 3. Loss, $50,000.

COUNCIL BLUFFS, IA.—The Council Bluffs, Tabor & Southern Railway Company has applied to the City Council for a franchise for the Interurban Terminal & Belt Line Company to construct terminal and belt lines.

JOPLIN, MO.—The Joplin, Neosho & Peirce City Interurban Railroad Company has been incorporated. The general offices will be in Neosho. It is incorporated for $50,000. One-half the stock has been subscribed and 10 per cent paid in. The directors are Charles Cunliff, Wm. S. Brawner, John Kimpel, John Weathers and Benjamin Cunliff, all of St. Louis.

ROME, N. Y.—The officials of the Rome City Electric Railway Company are considering the matter of extending the line through North Rome.

NEW YORK, N. Y.—The Interborough Rapid Transit Company has applied to the Rapid Transit Commission for leave to extend the subway from the terminal to Kingsbridge by an elevated railroad to Van Cortlandt Park. The length of the extension will be about a mile, and will cost about $490,000.

ITHACA, N. Y.—The State Board of Railroad Commissioners has granted a charter to the Ithaca & Cortland Traction Company. The new road will open up a rich farming country and will afford a quick means of travel between Ithaca, Dryden and Cortland. George Archer and H. L. Chandler, of Philadelphia, are directors of the company.

ONEIDA, N. Y.—The Oneida Railway Company has been granted a franchise which gives the company permission to cross the Seneca Turnpike at the head of Main Street, and to cross West Road a little further south. These crossings are part of the revived route to be followed by the company in building the extension from Oneida to Kenwood and Sherrill.

SYRACUSE, N. Y.—Upon application of the directors, the Syracuse, Lakeside & Baldwinsville Electric Railway Company has gone into bankruptcy, and William B. Rockwell has been appointed receiver. The road has a floating indebtedness of $135,000, and has been unable to pay the interest on its bonds. The immediate cause of the receivership is the action brought by Lieut.-Gov. William M. Brown, of New Castle, Pa., to recover interest on $26,000 worth of bonds. Mr. Rockwell, the receiver, is general manager of the road.

MARION, OHIO.—C. Crissinger, of Marion, is securing franchises and right of way for a road from Marion to Bucyrus. A franchise is now pending in the latter place.

BRIDGEPORT, OHIO.—The Wheeling Traction Company is planning to build a line from Bridgeport to Pasco and Barton. The road may eventually be extended to Cadiz.

ZANESVILLE, OHIO.—Surveys have been started for the line of the Perry Electric Railway, Light & Power Company, which is to extend from Zanesville to New Straightsville. It is claimed that practically all the right of way has been secured.

CLEVELAND, OHIO.—The Cleveland, Chardon & Meadville Railway Company has been incorporated in Ohio, with $25,000 capital stock, by H. A. Stahl, T. H. Hogsett, W. C. Warner, Monroe Warner and A. R. Warner. The company was incorporated last summer under the laws of Pennsylvania, and it is stated that a private right of way over the route from Chardon to Meadville has already been obtained.

COLUMBUS, OHIO.—The Columbus Railway & Light Company has given a contract for an automobile truck which will carry jacks and other equipment to render temporary aid to disabled cars, and in addition will carry four hose bridges for use at fires. The truck will have a maximum speed of 15 m. p. h., and it will respond to all fire alarms in the central portion of the city. The Columbus Company already operates an automobile tower wagon.

HARRISBURG, PA.—A charter has been granted to the Monroe & Northampton Street Railway Company, 15 miles long. It has a capital of $90,000.

LANCASTER, PA.—Nearly all the right of way between Leaman Place and Ronk's has been secured for the Lancaster & Eastern Electric Railway Company.

WAYNESBORO, PA.—The Chalmersburg, Greencastle & Waynesboro Electric Railway Company has completed its line to Greencastle, and has placed an order for a large amount of trolley wire with the Magnet Wire Company, of New York.

PITTSBURG, PA.—The Pittsburg Railways Company has secured the franchises for an extension of its lines from Avalon through the borough of Ben Avon to the Eastern limits of Emsworth. The extension will be 2½ miles long, and will require the building of a steel viaduct.

LANCASTER, PA.—A charter has been granted to the Philadelphia, Coatesville & Lancaster Passenger Railway Company, capital $40,000, to build a line 22 miles long, extending from Coatesville to Strasburg. A power house will be erected at Christiana, and the line equipped with ten four-motor cars.

SCRANTON, PA.—The Scranton Railway Company will spend about $500,000, it is stated, on betterments to its system the coming year. Later in the month the board of directors will pass upon these contemplated improvements. A number of lines are to be double tracked, and a number of new cars purchased.

HARRISBURG, PA.—The Valley Traction Company has been chartered with these directors: Mr. McKennedy, George H. Stewart, Lyman D. Gilbert, Spencer C. Gilbert and Lewis S. Sadler, all of whom are interested in the Cumberland Valley Railroad Company. It is stated that the new company will control and merge the Harrisburg and Mechanicsburg, Harrisburg & West Fairview, West Fairview & Marysville and the White Hill & Mechanicsburg Electric Railway systems, and expects to get control of the system of the Cumberland Valley Traction Company, with lines in Carlisle and between Mechanicsburg and Carlisle.

YARDLEY, PA.—The Yardley, Newhope & Lambertville Street Railway has been incorporated at Harrisburg for the purpose of building a line from this borough to Newhope, opposite Lambertville, a distance of about 11 miles. The capital of the company is $100,000, and T. Sidney Cadwalader, of this place, is president. W. F. Sadler, Jr., of Trenton, N. J., is also interested. It is understood that a bridge, to cost about $50,000, will be erected in place of the wooden structure swept away in October, and that a line will be constructed from Trenton to Lambertville, and thence up the Pennsylvania side of the Delaware River to Newhope.

EDMONTON, N. W. T.—The people in this town are moving for an electric street railway, and have decided upon submitting to the people for approval a by-law to provide for the construction of a municipal system.

WALKERVILLE, ONT.—The Ontario Traction Company, Ltd., has been incorporated, with a capital stock of $50,000, to construct an electric railway in Walkerville, Ont. The incorporators are C. M. Walker, E. F. Lardore and J. H. Coburn, of Walkerville; Franklin Ohl, Willis F. Brown, of Toronto.

NEW INDUSTRIAL COMPANIES.

THE INTER-STATE MARINE TELEGRAPH COMPANY, of New York City, has been incorporated; capital, $10,000. Directors: T. J. Ryan, E. Haussner and F. E. Sharot, New York.

THE ALLIED ELECTRIC CORPORATION, with a capital stock of $1,000,000, has been incorporated in Los Angeles, Cal. The directors are M. V. McQuigg, C. W. Allen, R. C. P. Smith, K. R. Smith and J. M. Gardiner.

THE O'KANE-HULL COMPANY, of Columbus, Ohio, capital stock $25,000, has been incorporated by W. C. O'Kane, R. E. Hull, G. R. Heges, Frank M. Raymond and Ira A. Crumm. The company will manufacture electrical machinery.

THE TRACTION DEVELOPMENT & SECURITIES COMPANY, of New York City, has been incorporated with a capital stock of $200,000. The directors are S. B. Manning, Henry Oppenheimer and C. C. Marshall, of New York City.

THE IMPERIAL TRANSIT COMPANY has been incorporated at St. Louis to operate an automobile coach line between the city and the World's Fair. The company, which was incorporated by A. Levy, H. M. Dalton and H. C. Pickett, is capitalized at $600,000, full paid.

THE MONARCH INCANDESCENT LAMP COMPANY.—The stockholders of the Monarch Incandescent Lamp Company of Warren, Ohio (recently incorporated) have elected the following-named officers: C. H. Sager, president; Frank Myers, vice-president; J. F. Kistler, superintendent. The company has located its factory in Warren.

OBITUARY.

MR. T. C. FRENYEAR.—Mr. Thomas Cyprian Frenyear, sales manager of the new Canadian Westinghouse Company, died of typhoid fever at Fort William, Canada, on Dec. 10. He was a man of exemplary life, unusual business judgment and ability, and was remarkable for the clearness and force of his ideas. As an electrical engineer he was a good adviser. His is the first death in nearly five years among the higher officials of the Westinghouse Electric Company. He was the son of the Rev. T. C. Frenyear and was born on March 16, 1865, at Middletown Spa., Vt. He began his business career before he was 15 years old, in the office of the Boston Electric Company, where an uncle, Mr. W. R. Nutting, was manager. While there he entered the Latin School, doing his studying at night. Thence he went to Phillips Exeter Academy, paying his way by keeping a bookstore for students. He was graduated in 1885. He entered Harvard that autumn, but could not spare time to continue the course. He afterward entered the Boston University, but a business reverse put an end to his efforts to gain a collegiate degree. For several years after he was in the employ of the Thomson-Houston and Brush Electric Companies as salesman, with his headquarters in Buffalo. From 1892 to 1895 he was superintendent of the Cayadutta Electric Railroad. In the fall of 1895 he entered the employ of the Westinghouse Electric & Mfg. Company. He was connected with the sales office of that Company until Nov. 1, 1903, when he was placed in charge of the sales department of the new Canadian Company with headquarters in Toronto. He was married to Miss Emma L. Chase, of Exeter, on June 28, 1893. Mrs. Frenyear and three children survive him. Mr. Frenyear was a deacon and trustee of the Delaware Avenue Baptist Church, of Buffalo, and had been superintendent of the Sunday School. In announcing the death to the officials of the Westinghouse Company, Vice-president Taylor said: "The management desires to place on record its thorough appreciation of his able and loyal service and of the loss to the Westinghouse interests by the untimely removal of a young and zealous official whose future seemed so full of promise."

PERSONAL.

MR. FRANCIS BLOSSOM, of Sanderson & Porter, is back from an extended Western trip.

MR. F. S. WILLIAMSON, of Chas. H. Davis & Partners, has sailed for a trip to England.

MR. JOHN M. ANDERSON, treasurer of the Albert & J. M. Anderson Mfg. Company, of Boston, was in New York last week.

MR. W. H. HARVEY, of Memphis, Tenn., has in hand plans for a plant for the Wesson Light & Power Company, of Wesson, Miss.

MRS. FREDERICK R. SCOTT, of Richmond, Va., has donated $10,000 to the University of Virginia for an electrical engineering laboratory.

MR. JOHN G. EMERY, general manager of the Shaw Electric Crane Company of Muskegon, Mich., is in New York for a few days at the offices of Manning, Maxwell & Moore.

MR. E. W. STEVENSON, electrical engineer of the Hazard Mfg. Company, Wilkesbarre, Pa., has been spending several days for recreation, etc., in New York City, where he is very much at home.

MR. N. WINGFIELD, Augusta, Ga., is preparing plans for an electric plant at Sandersville, Ga., including three 100-hp boilers, two engines of 150 and 75-hp respectively, two generators of 50 and 100-kw respectively, piping, etc.

MR. H. C. FRICK, the steel millionaire, is reported to be prominent in the affairs of the Pittsburgh Reduction Company, which makes nearly 80 per cent of the aluminum in this country, the product being estimated at 10,000,000 pounds last year, all told.

MR. GEO. L. COLGATE, of Batavia, N. Y., well known in electric light and manufacturing circles, has been developing the project of delivering Niagara Falls power in Batavia and ten miles of the right of way has already been secured. It looks as though the scheme would be carried out.

MR. TOWNSEND WOLCOTT and Mr. R. A. Klock are referred to in high terms of praise in regard to their professional services for the department, by Gen. A. W. Greely in his annual report as Chief Signal Officer, U. S. A. Mr. Walcott is also described as "an electrical engineer of marked ability and great practicability."

MR. P. B. DELANY, the electrical engineer, who has been inventing and perfecting telegraphs all his life, states that he now has ready a perfect automatic machine telegraph capable of 3000 words per minute. He has been working on this for a long time past. Mr. Delany's work in this direction has already been noted in our columns.

MR. PETER COOPER HEWITT is the third member of the Automobile Club of America to enter for a place on the team to represent this country in the race for the Bennett International Automobile Racing Trophy in Germany next year. His entry, which was received at the Automobile Club last week, named his car as being built at the iron works at Trenton, N. J., in which Mr. Hewitt is interested, and it is presumed that it is of his own design.

PROF. D'ARSONVAL.—The Paris *Matin* the other day printed an interview with Professor d'Arsonval in which the latter declared that France, after having had the glory of discovering radium, is now in danger of being left behind by England and America for want of funds to carry on experiments. The *Matin*, therefore, has determined to come to his assistance and has presented Professor d'Arsonval with 30,000f. ($6000) for work in this direction.

MR. ALEX. HENDERSON celebrated his birthday on Dec. 21 and would have done so quietly if a number of New York friends had not invaded his privacy as a "surpise party," bent on making closer acquaintance with the loving cup presented to him a few months ago. Some thirty showed up, including Messrs. Eidlitz, Hatzel and Blackall, who voiced the sentiments of their fellow conspirators in regard to the involuntary host of the evening. Altogether a most delightful time was spent.

MR. CHAS. J. REED has requested us to announce that owing to press of professional work, it will be impossible for him to serve another term as secretary of the American Electrochemical Society, and asks that votes for this office may be cast for others. As one of the originators of the society and the guiding spirit during its life up to the present, the determination of Mr. Reed to retire from its active direction is much to be regretted, but we learn that he will under no circumstances reconsider his declination.

MR. C. W. DARLEY, ex-engineer-in-chief of the public works of the New South Wales government, who now holds the position of inspecting engineer attached to the office of the agent general for New South Wales in London, has sailed for England after several weeks' visit on this side. He came here to inspect some of the large water power and irrigation plants, and the report he will make will, it is understood, in Australian trade circles here, contain recommendations as to the placing of some substantial contracts on this side.

COMMERCIAL CABLE MEN.—The third annual staff dinner of the employees of the Commercial Cable Company took place at Shanley's on December 14. More than a hundred of the men gathered about the tables. Among those present were George G. Ward, vice-president of the company; George Clapperton, traffic manager; C. E. Merritt, assistant treasurer; J. H. Smart, superintendent of the station in this city; F. S. Austin, assistant superintendent; F. H. Dennis, chief of the Clearing House Department, and Charles C. Cuttriss, chief electrician. Telegrams were received from all the superintendents of the company and from Mr. Clarence H. Mackay, in which regrets were expressed at being unable to attend.

MR. H. M. WHITNEY, of Boston, has been to Ottawa to make a proposition to the Minister of Marine for the adoption of the Gray-Mundy electric submarine signal in Canadian waters. The United States Government, it is said, is arranging to have a commission to report upon the invention with a view of adopting it in American waters. Minister Prefontaine says: "If everything turns out as I expect it will, the next season of navigation will see these signals established all along the St. Lawrence and Atlantic Coast. Parliament has already given the department and the Government a pretty free hand in providing aids to navigation so that the St. Lawrence route may be made not only perfectly safe to mariners, but that not a vestige of complaint can be laid against it by those who are inclined to do so at present."

MR. LA RUE VREDENBURGH, who will present at the twenty-seventh convention of the National Electric Light Association, to be held in Boston, a report on advertising methods for central stations, has sent out a circular to members of the association asking them to give expressions of opinion as to the methods they have found most effective along this line; what their experience has been as to traceable results from such advertising as they have done, and requesting them to forward him for use in his report samples of advertising matter that in their opinion have been best business bringers. Mr. Vredenburgh will also make a similar request of a large number of foreign central station companies, with a view of comparing methods in this country and abroad, as well as giving the Association the benefit of any novel ideas that it would be well to adopt here. The report will have an immense practical value for all members wishing to extend their business.

BULLOCK CHANGES OF PERSONNEL.—Several personal changes in the Bullock Electric Mfg. Company have become necessary owing to the very marked demand for its apparatus. Mr. Halbert P. Hill has become connected with the Bullock Electric Mfg. Company and will take charge of their exhibit at the St. Louis Fair in 1904. Mr. Hill represented the General Incandescent interests here in New York City, and was sales manager for the Storey Company until they passed out of existence. Mr. W. L. Fairchild, late treasurer of the J. F. Kelly Engineering Company, joined the forces of the company and will operate from the New York office. Mr. A. F. Rolf, assistant to Mr. R. T. Lozier, at Cincinnati, has been transferred to the New York office as assistant district manager of that office, Mr. E. W. Goldschmidt being the district manager. Mr. Walter B. Spellmire, district manager at Atlanta, has taken the position of the vice-presidency of the A. W. Wyckoff Company, at Pittsburg, who succeed the Pittsburg Engineering Company, as representatives of Bullock interests in that territory. Mr. G. C. Henry, general manager of the Florida Electric Company takes Mr. Spellmire's place as district manager at Atlanta.

MR. GEO. WESTINGHOUSE, while in the city just previous to sailing on the *Kaiser Wilhelm* to attend the the annual meeting of the stockholders of the British Westinghouse Company, gave a most encouraging opinion regarding industrial prosperity during the coming year. During the week ending Dec. 4th, Mr. Westinghouse met at Pittsburg, twenty-three district managers from Atlanta, Dallas, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Minneapolis, Philadelphia, St. Louis, Syracuse, Seattle, Salt Lake City, San Francisco, Los Angeles, Denver, Toronto and the City of Mexico. Each manager was requested to make a report as to the industrial conditions of his territory and its probable demand for Westinghouse machinery for 1904. Thirteen reported unusual activity with probably greatly increased demands. The other nine, all but two, reported as strong a demand as during the past year with probable increase. Two only expected to hold their own or on account of local conditions, have a smaller demand. Mr. Westinghouse on these reports, had directed improvements and enlargements to provide for the demand and is exceedingly optimistic as to activity in the future. He thinks the lowest point of the ebb tide of industrial depression has been reached and that 1904 will be a year of added prosperity.

Trade Notes.

TROLLEY CAR LIGHTING.—The Kinsman Electric & Railway Supply Company, 91 Liberty St., New York City, is introducing and recommending its new Kinsman supplementary car lighting system which never leaves the car in darkness and thus prevents panics, robberies, collisions, etc.

THE CENTRAL ELECTRIC COMPANY is enthusiastically calling attention to its "I. X. L." weatherproof, slow-burning waterproof wires. These high grade wires, the company says, are unsurpassed and are meeting with a popular reception. Prospective buyers are urged to obtain prices, samples and full information concerning them from the company.

"SALUS" COMPOUND.—Those who have never heard of "Salus" compound, the new insulation for Packard transformers, are requested to write to the transformer department of the selling agents, the Electric Appliance Company, Chicago, who will give complete data on transformers and transformer insulation.

WARREN ROTARY ENGINE.—The Rotary Engine Company, 135 South Second Street, Philadelphia, has issued a handsome 16-page bulletin describing and illustrating in detail the Warren rotary steam engine. To those interested in new developments in steam engineering this pamphlet will be welcome, as it explains in detail the new principles whose application has enabled the great desideratum of a mechanically efficient rotary engine to be practically realized.

WESTINGHOUSE IN CANADA.—A circular has been issued calling attention to the Canadian Westinghouse Company, whose formation has already been frequently noted in these columns, intended to take over the Canadian business and interests of the Westinghouse Electric & Mfg. Company. It has works at Hamilton, Ohio, and sales headquarters at Toronto. The apparatus in Canada will be designed by the same engineers and made under the same system as that produced in the United States. The company will devote its energies solely to the development of business in Canada.

THE STANDARD ELECTRICAL MANUFACTURING COMPANY, Niles, Ohio, reports a gratifying increase of business this fall, which proves that "Star" lamps are steadily growing in popularity. This is particularly true of its numerous types of sign, candelabra and other decorative lamps. Instead of slighting or side-tracking this department, as is so often the case, the same painstaking care in choice of materials, construction and exhaustive testing is exercised, as in the manufacture of standard types. A liberal choice of styles and colors is allowed. All these are illustrated and described in the attractive catalogue recently issued, which can be obtained on application.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DECEMBER 15, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

746,337. ELECTRICALLY CONTROLLED VALVE; Oscar Junggren, Schenectady, N. Y. App. filed Nov. 15, 1902. Two electro-magnets control respectively steam passages leading to two pistons on a valve stem, one for opening the valve and the other for closing it.

746,669. CURRENT REGULATOR; George A. Cardwell, New York, N. Y. App. filed March 21, 1903. Means for varying the duration of the time intervals during which currents of predetermined strength flow through a circuit and means for diminishing the full value of the current in the circuit as the duration of the time intervals decreases, thus affording regulation without breaking the circuit.

746,671. INSULATOR; Taylor Carter, Frankfort, Ky. App. filed Sept. 12, 1903. Eccentric jaws are pivoted to an insulating block to secure the wire to the block.

746,672. ENGINE STOP; James H. Cary, Providence, R. I. App. filed July 28, 1902. An emergency stop consisting essentially of a circuit containing a relay which actuates a motor circuit to move the throttle valve.

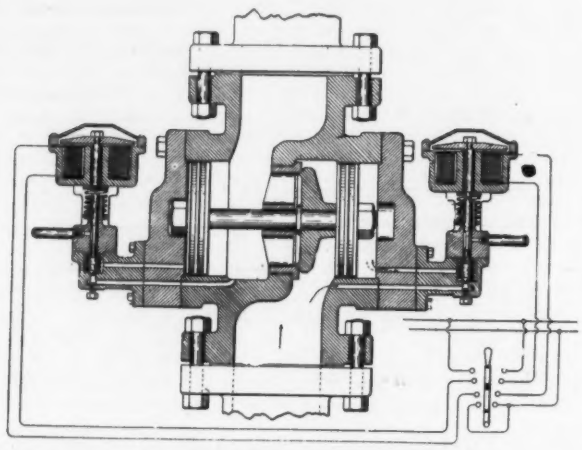
746,690. SYSTEM OF TELEGRAPHING OR TELEPHONING TO OR FROM RAILWAY VEHICLES; James Edgar, Wrexham, England. App. filed June 29, 1903. (See page 1058.)

746,695. AUTOMATIC ELECTRIC SWITCH; William S. Guthrie, Terrell, Tex. App. filed June 19, 1903. A switch for an electric sign in which levers are moved into connection with contact studs by a rotating drum carrying pins on its surface; the contact studs are spring mounted so as to yield and prevent breaking or bending of the levers.

746,697. SYSTEM OF ELECTRICAL DISTRIBUTION; Josef H. Hallberg, New York, N. Y. App. filed May 28, 1903. A system wherein current traversing the field magnets of a main generator is automatically varied to maintain a uniform potential in the distributing circuit by varying the speed of a motor in accordance with the work in the distributing circuit, said motor driving a generator which delivers a current in opposition to the exciting current of the fields of the main generator.

746,726. ELECTRICAL SIGNAL SYSTEM; Ulysses G. Merrill, Litchfield, Me. App. filed Sept. 10, 1902. Details.

746,748. APPARATUS FOR REFINING METALS; Alfred Schwarz, New York, N. Y. App. filed April 10, 1903. (See page 1058.)



746,337.—Electrically Controlled Valve.

746,751. CURRENT COLLECTING DEVICE FOR ELECTRIC RAILWAY SYSTEMS; Abraham A. Shobe and William Embley, Jerseyville, Ill. App. filed April 10, 1903. A current collector adapted to enter a conduit and being constructed to compensate for vertical movement of the car and thus constantly maintain good connection with the conductor.

746,772. ELECTRICAL SWITCH BOX APPARATUS; George L. Addenbrooke, Westminster, England. App. filed May 17, 1902. Consists of a pressure-ratio and a current-ratio set of resistances controlled by switches, combined with means for connecting them to a battery resistance, various meter circuits and a standard cell, the apparatus being used for testing.

746,775. PRODUCING APPROPRIATE PHASE RELATIONSHIP IN ALTERNATING CURRENT MEASURING OR OTHER DEVICES; Riccardo Arno, Milan, Italy. App. filed Feb. 8, 1900. Consists in energizing one set of inducing coils with the current flowing in one of the multi-phase mains and energizing the other set or sets of inducing coils by a current due to the properly proportioned amount of electromotive forces derived from currents flowing in the other mains of the multi-phase system acting through magnetic media.

746,795. PROCESS OF MANUFACTURING ALKALI CYANIDS; Paul Danckwardt, Deadwood, S. D. App. filed June 10, 1903. (See page 1058.)

746,796. PROCESS OF SIMULTANEOUSLY PRODUCING ALKALI CYANID AND ALKALI METAL; Paul Danckwardt, Deadwood, S. D. App. filed June 10, 1903. (See page 1058.)

746,797. PROCESS OF SEPARATING METALS FROM MATTE OR ORE; Paul Danckwardt, Deadwood, S. D. App. filed June 20, 1903. (See page 1058.)

746,798. PROCESS OF RECOVERING ZINC FROM SULFID ORES; Paul Danckwardt, Deadwood, S. D. App. filed Aug. 15, 1903. (See page 1058.)

746,830. ELECTRIC ARC LAMP; Thomas Hamilton-Adams, London, England. App. filed June 4, 1903. The parts of the clutch also constitute parts of the core of the solenoid, and being magnetized grip the carbon rod.

746,860. TROLLEY CATCHER; Horace R. Martin, East Bloomfield, N. Y. App. filed Aug. 7, 1903. A pneumatic apparatus for winding up the rope that retains the trolley arm in case the wheel leaves the wire.

746,903. ELECTRIC RECEIVER CLOCK; Johannes W. H. Uytenbogaart, Utrecht, Netherlands. App. filed May 6, 1903. The circuits of the permanent magnets are maintained closed while the magnets are not in use.

746,904. MAGNETO GENERATOR; George E. Wheeler, Burlington, Ia. App. filed Dec. 27, 1902. The spaces between the pole pieces above and below the armature are covered by plates to keep out the dust.

746,977. ELECTRIC RAILWAY SIGNALING SYSTEM; Charles W. Mills and William W. Piddington, Los Angeles, Cal. App. filed June 23, 1903. Details of a system wherein signals are displayed in the engineer's cab.

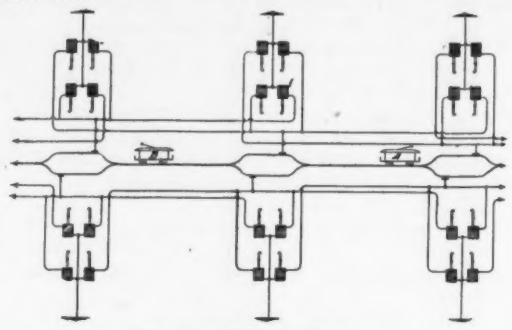
746,979. PARTY-LINE BELL; Leland Moore, Brooklyn, N. Y. App. filed April 16, 1903. (See page 1058.)

747,070. SIGNALING DEVICE FOR TELEPHONE PARTY LINES; Edward Oakman Hood, Hingham, Mass. App. filed Oct. 10, 1902. (See page 1058.)

747,106. TROLLEY; Milford J. Wilson, Painesville, Ohio. App. filed Sept. 2, 1902. A construction relating to the lubrication of the bearing through a hollow axle and to the contact between the wheel and stationary parts.

747,142. RAILWAY SIGNAL; Henry M. Cogan, New York, N. Y. App. filed April 23, 1903. A signal adapted for either single or double track trolley roads, by which more than one car moving in the same direction are permitted on a block at the same time, the first car to enter setting a danger signal ahead which is not cleared until the last car leaves the block.

747,155. TROLLEY SWITCH; Lloyd E. Elwell, Los Angeles, Cal. App. filed Aug. 17, 1903. A frame having two grooves one of which is depressed and acts in conjunction with a guiding flange to direct the trolley wheel onto a branch wire.



747,142.—Railway Signal.

747,166. THERMOSTATIC CIRCUIT CLOSER; Redman W. W. Grigsby, Chrisney, Ind. App. filed June 15, 1903. A casing having a stem to be inserted in a cavity of a bearing and containing a thermostatic circuit closer to indicate excessive heat in the bearing.

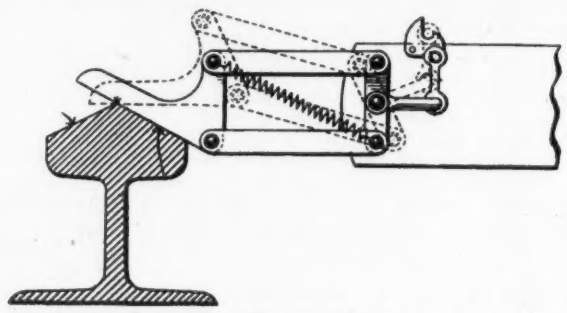
747,177. ELECTRIC RAILWAY; Maurice Hoopes, New York, N. Y. App. filed April 29, 1903. To enable the operation of third rails during the prevalence of sleet, the rail is formed with a ridge or corner from which it is easy to remove the ice by means of a blade of any character and then by shifting the shoe, to make contact with the ridge only, sufficient current will be collected by the various shoes of a train to keep up the headway.

747,185. ELECTRIC HEATER; Frederick W. Kelley and James F. McElroy, Albany, N. Y. App. filed May 17, 1897. The heater is in the form of a disk built up of spiral coils and insulating plates alternating with each other and mounted in a frame permitting of circulation of air.

747,212. DISPLAY LIGHT; Dennis J. O'Brien, San Francisco, Cal. App. filed May 20, 1902. The characters of a sign are formed by tubular lamps in which a filament is stretched, one end being fixed and the other flexibly connected with the terminals of the tube.

747,217. ELECTRIC MOTOR; Leroy S. Pfouts, Canton, Ohio. App. filed March 5, 1903. Two armatures in line with each other on independent shafts are located in the field of a single magnet, the armatures being independently geared to respective wheels of the vehicle.

747,234. BLEACHING PROCESS; Marcus Ruthenburg, Harrisburg, Pa. App. filed Feb. 14, 1903. (See page 1058.)



747,177.—Electric Railway.

747,236. POWER TRANSMISSION MECHANISM; Joseph S. Schaffer, Chicago, Ill. App. filed June 9, 1902. Two motors of high and low speed and large and small power, respectively, are mechanically connected together to drive a printing press, the controllers being constructed to start and control one motor and then cut in the other before the first is cut out.

747,277. ELECTRIC RAILWAY SYSTEM; Sivert Udstad, Aurora, Ill. App. filed Feb. 21, 1903. A cover carrying a third rail beneath it and feeders duly protected above it.

747,297. THERMOSTATIC APPARATUS; William H. Vristol, Hoboken, N. J. App. filed May 5, 1903. A combined thermostat and thermometer in which the indicator of the latter continues to operate in case the circuit controlled by the former is not effective in preventing a rise or fall of temperature beyond the limits.

747,305. ELECTRIC CLOCK; Vitalis Himmer, Jr., Bayonne, N. J. App. filed Oct. 9, 1902. Details.

747,317. LIFT; Robert F. Cary, Cricklewood, England. App. filed July 13, 1903. Details.

747,326. ELECTRIC RAILWAY SIGNALING SYSTEM; Charles W. Mills and William W. Piddington, Los Angeles, Cal. App. filed July 14, 1902. Details.

747,331. SUBSCRIBER'S TELEPHONE CIRCUIT; William W. Dean, Chicago, Ill. App. filed Dec. 23, 1903. (See page 1058.)

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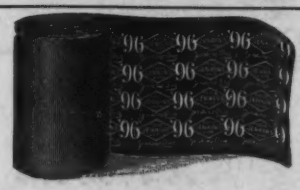

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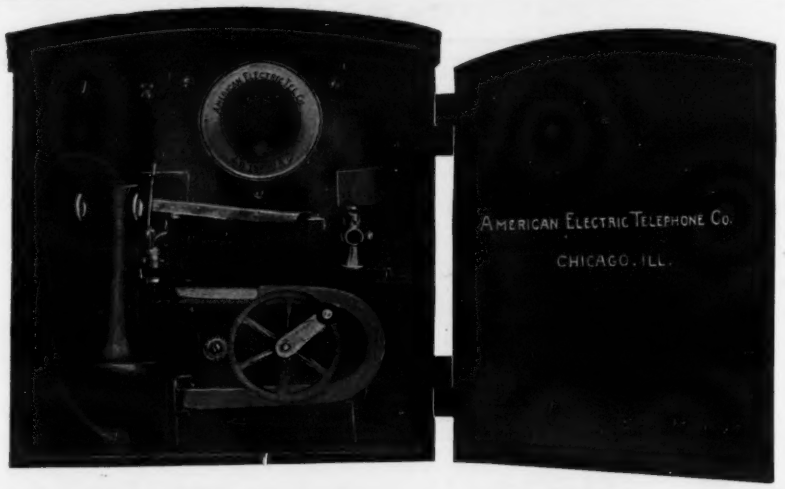

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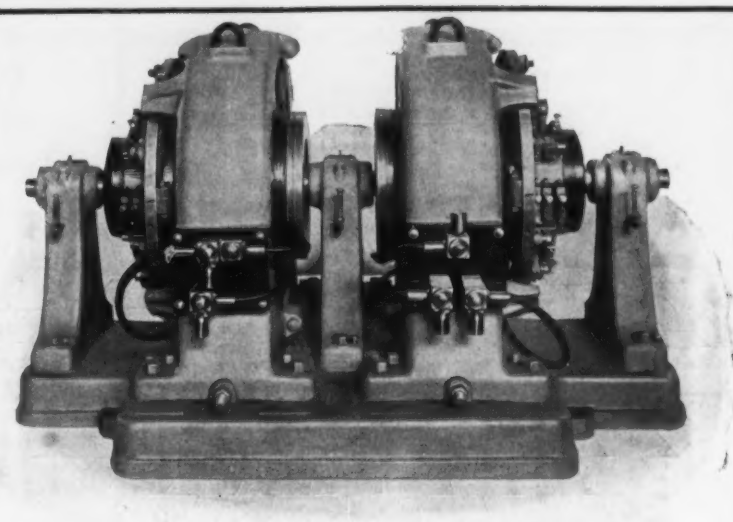

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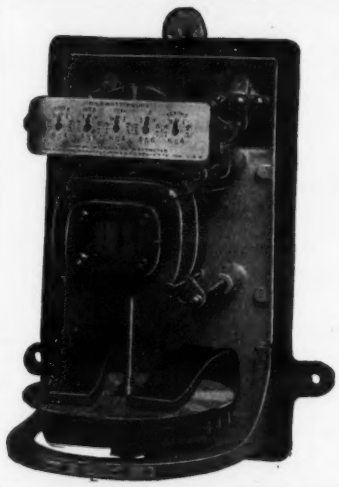

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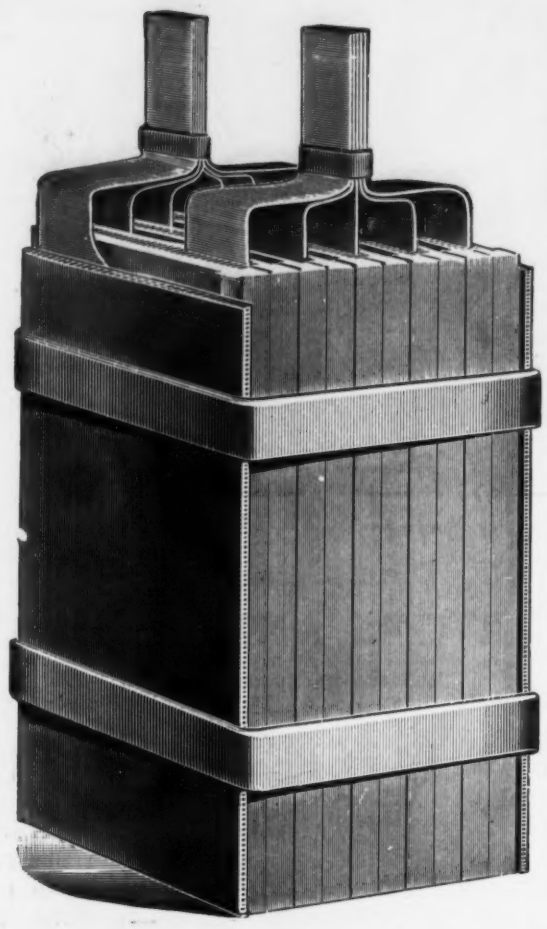

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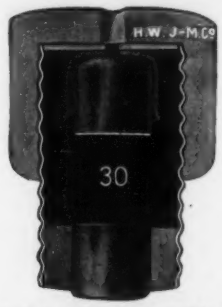

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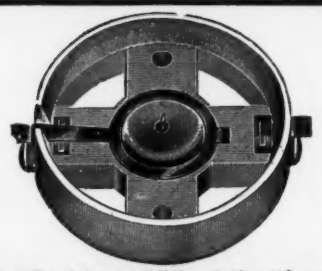

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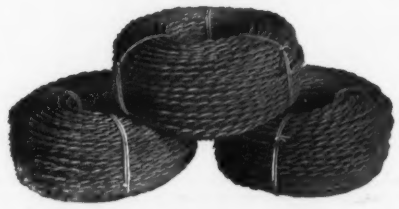

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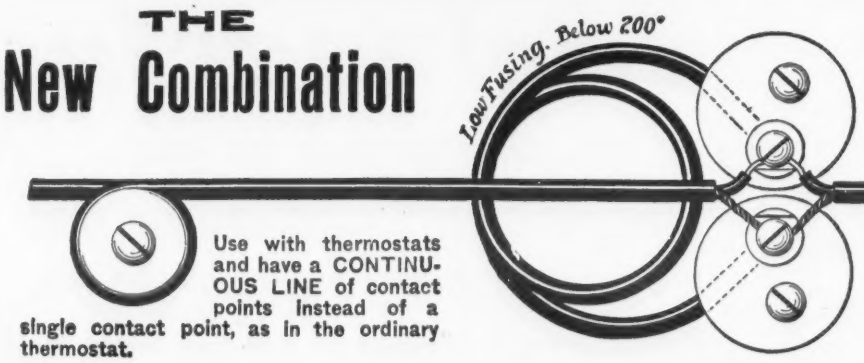

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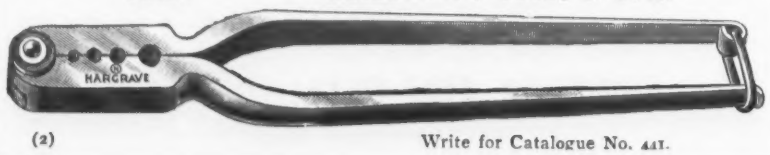

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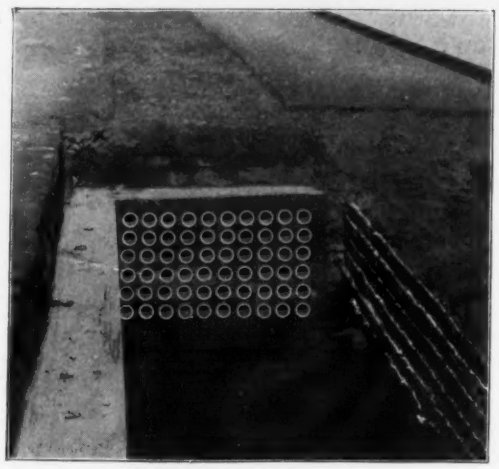

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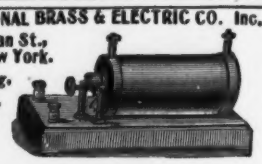

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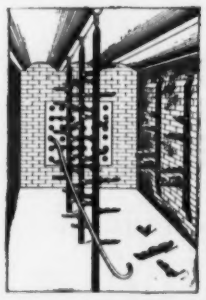

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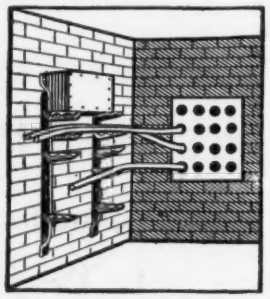

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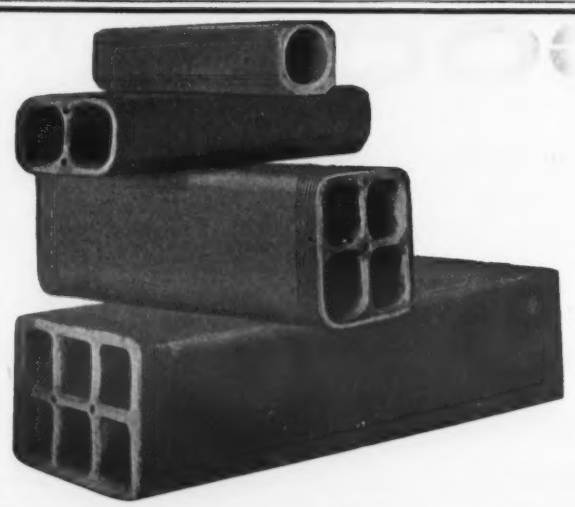

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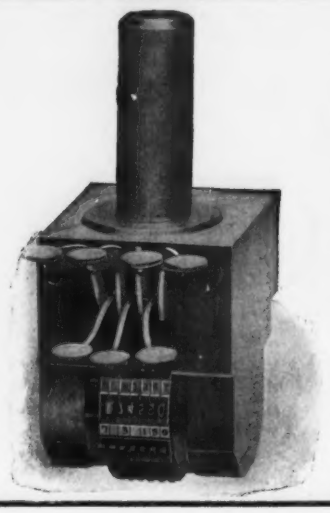

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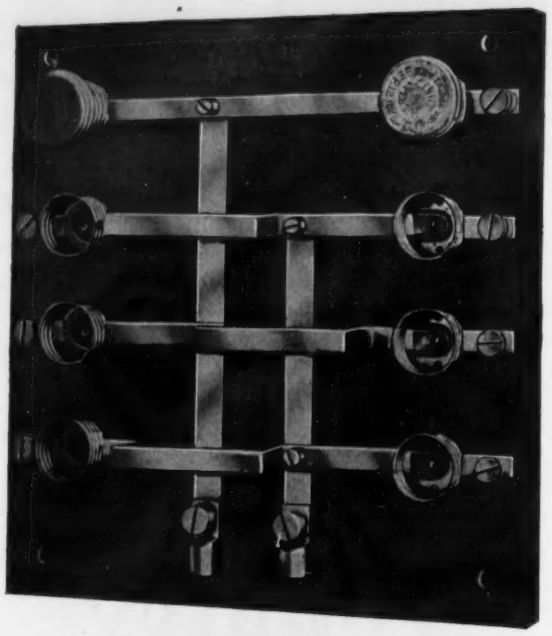

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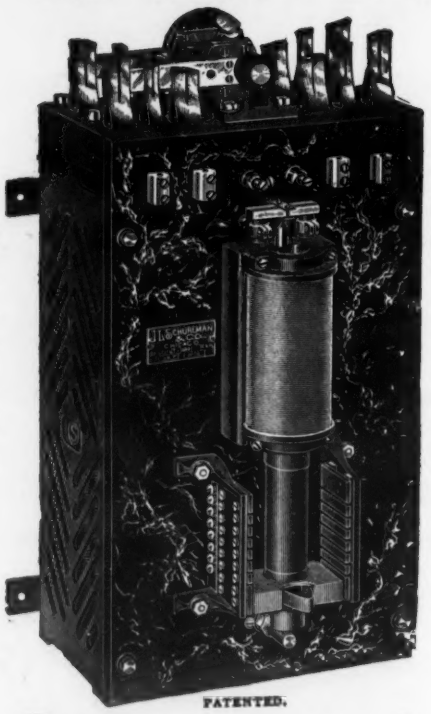

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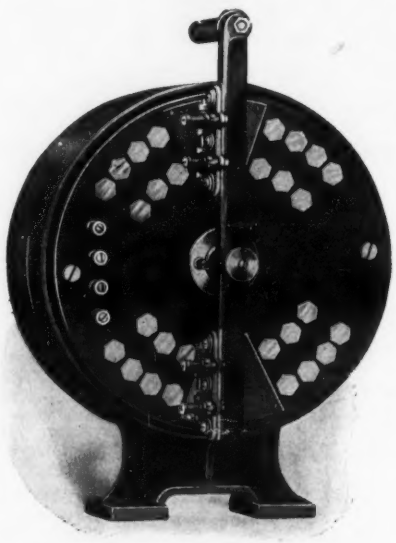

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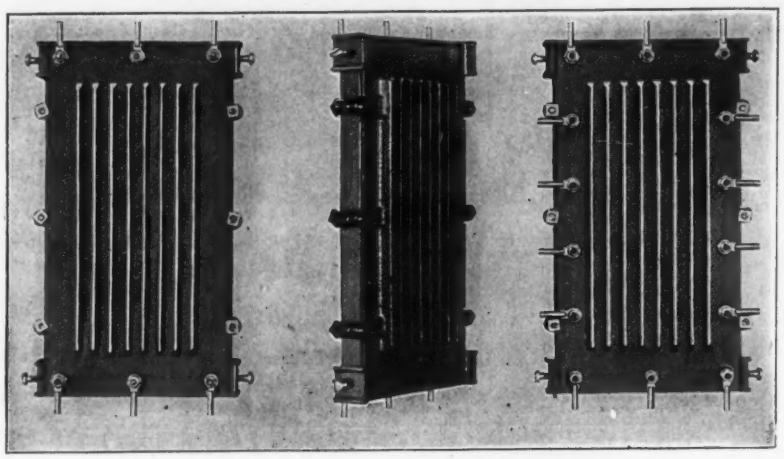

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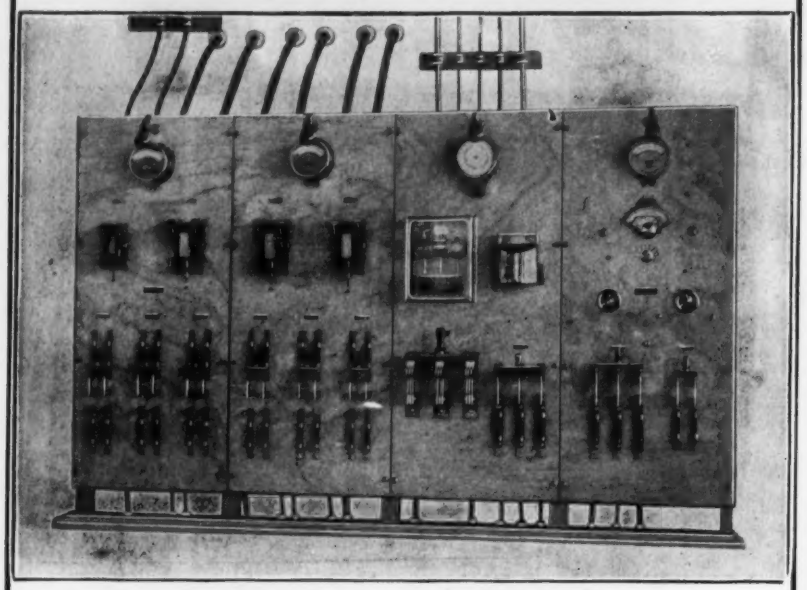

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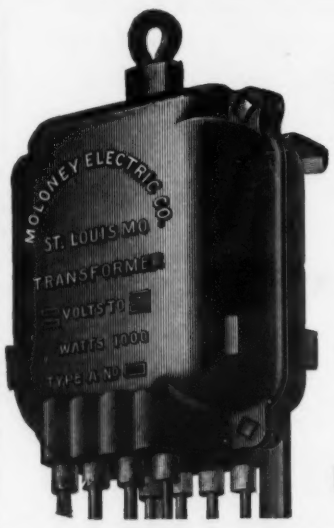

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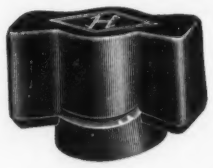

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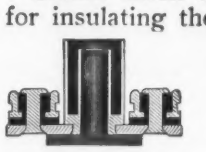

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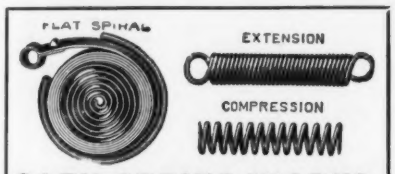

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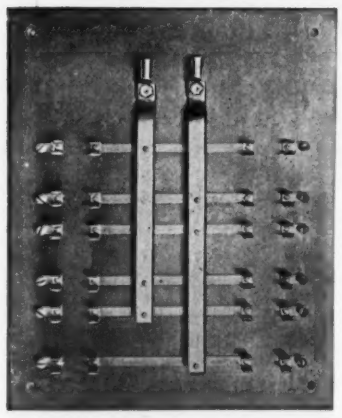

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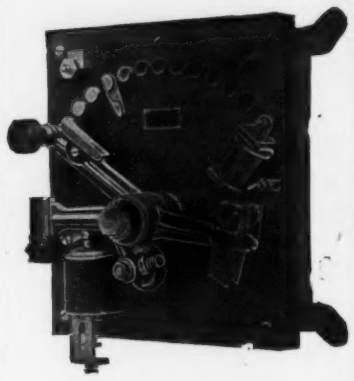

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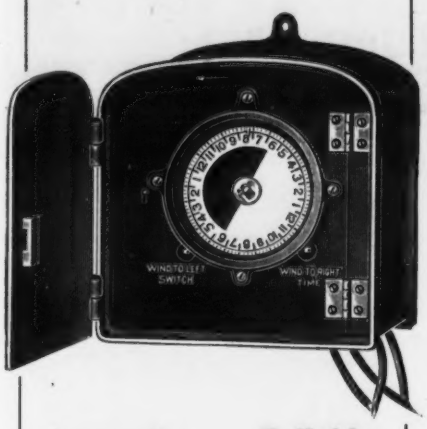

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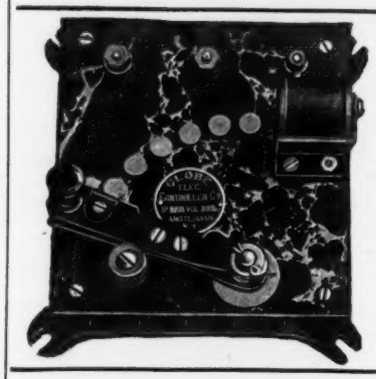

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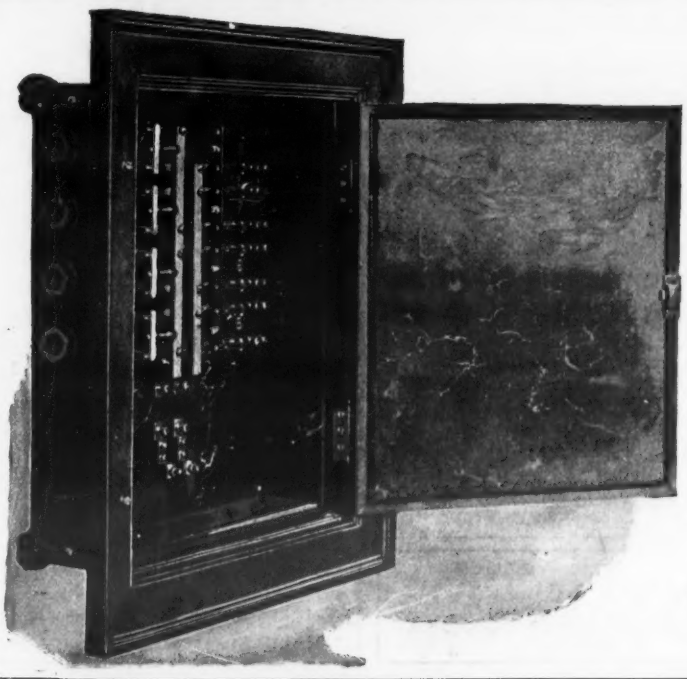

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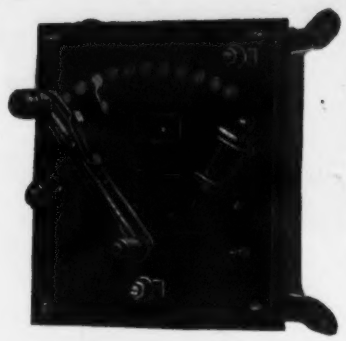

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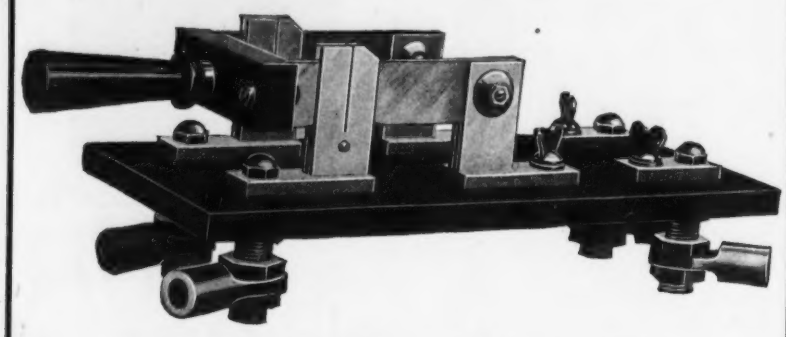

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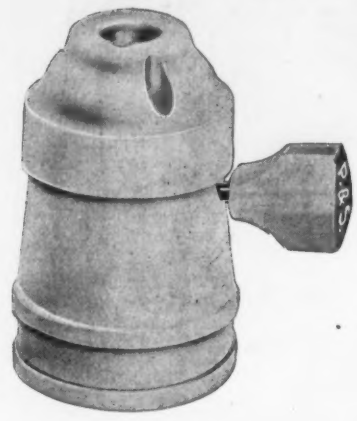

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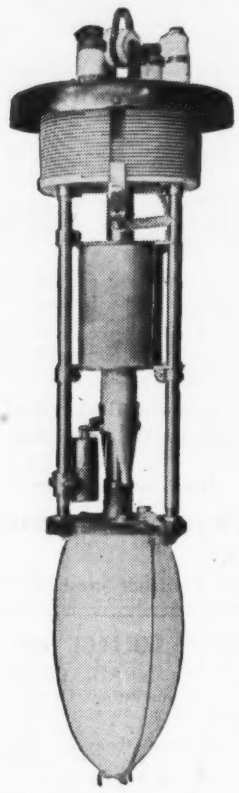

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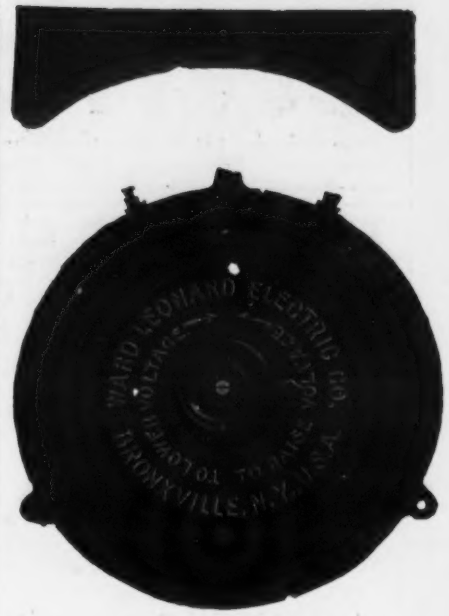

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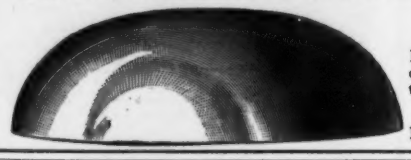

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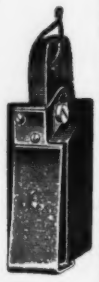

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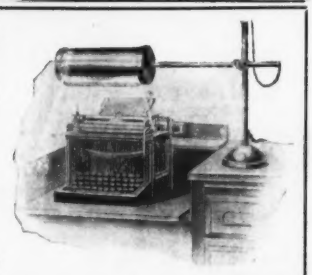

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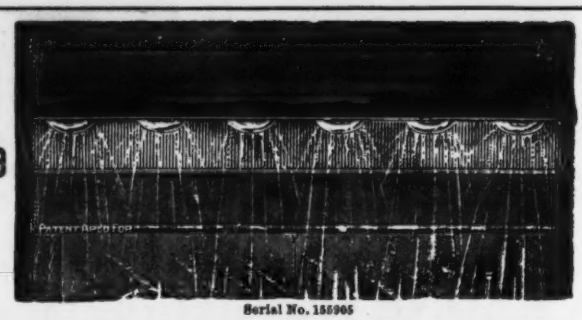

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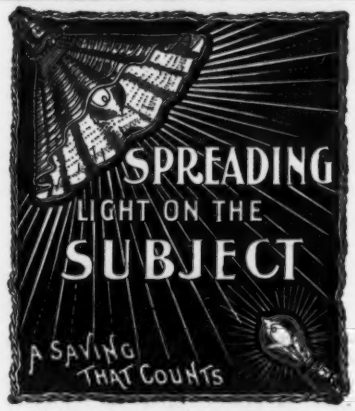

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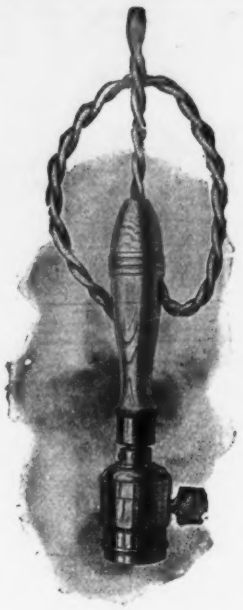

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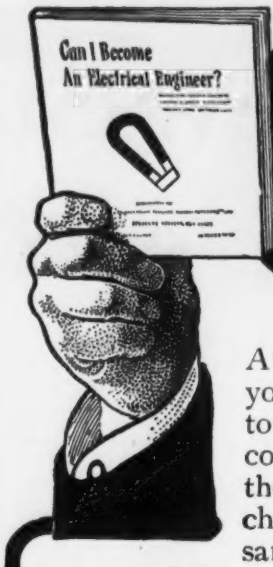

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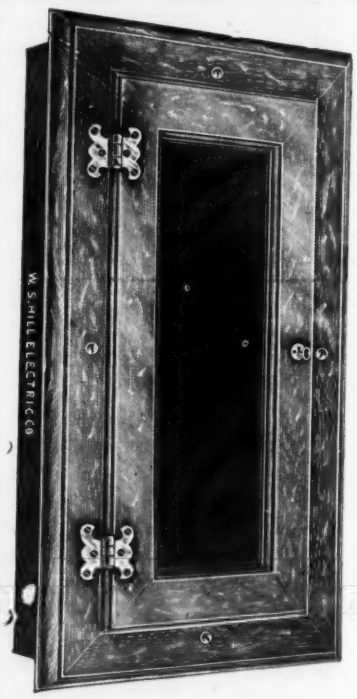

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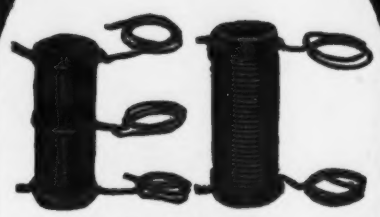

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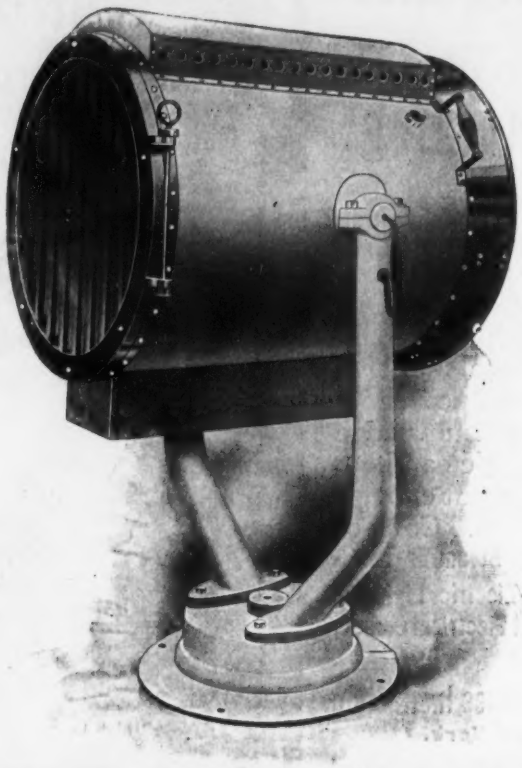

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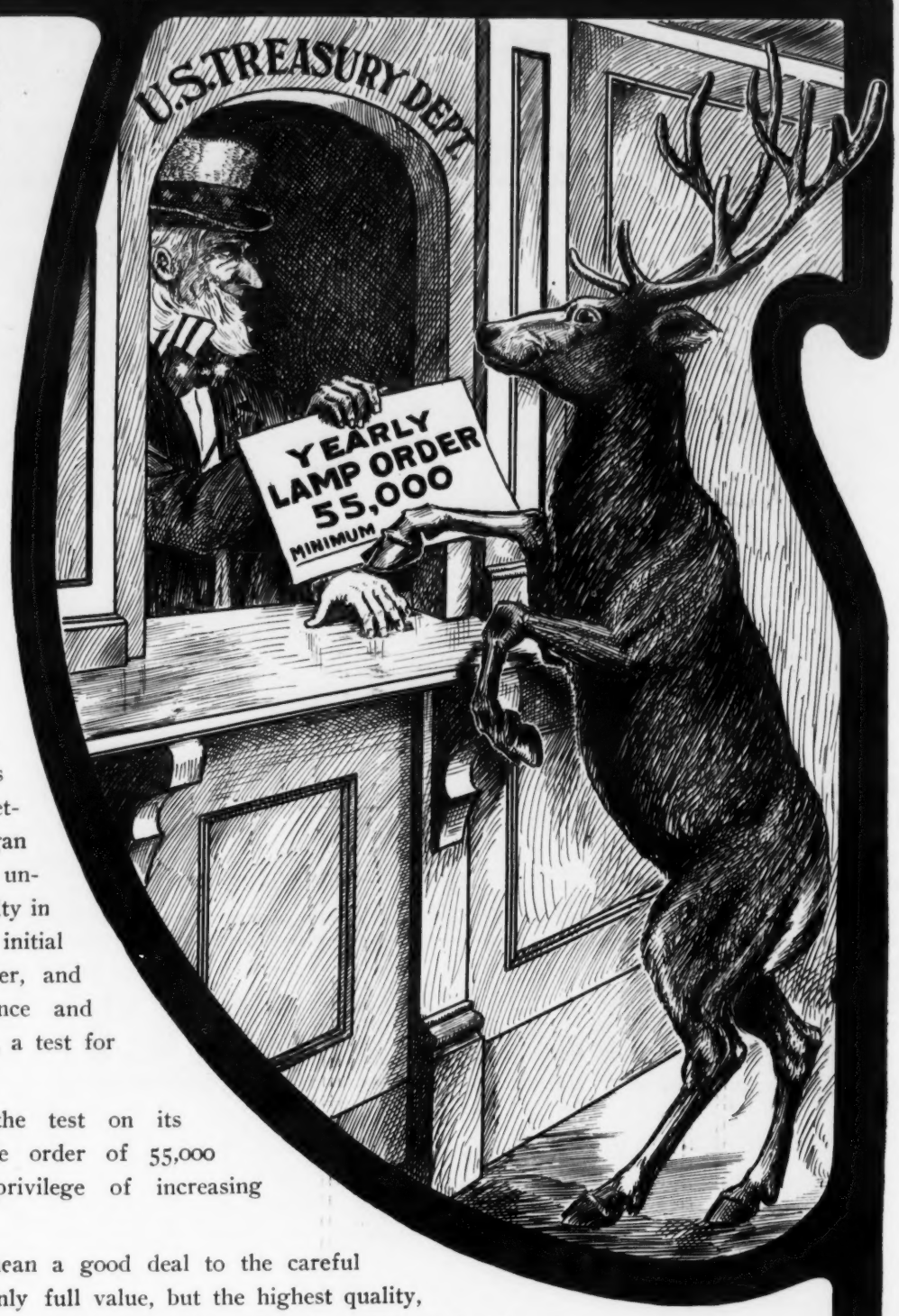

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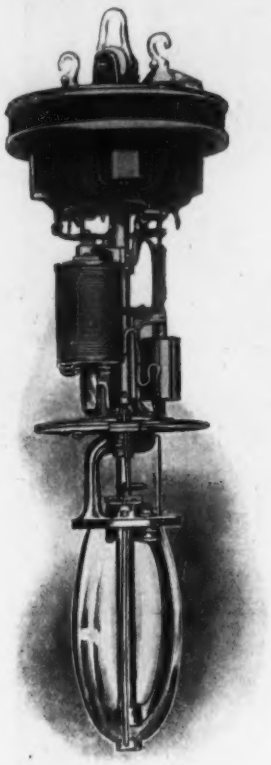

Side view of mechanism of L-6 Arc Lamp with closed base trim.

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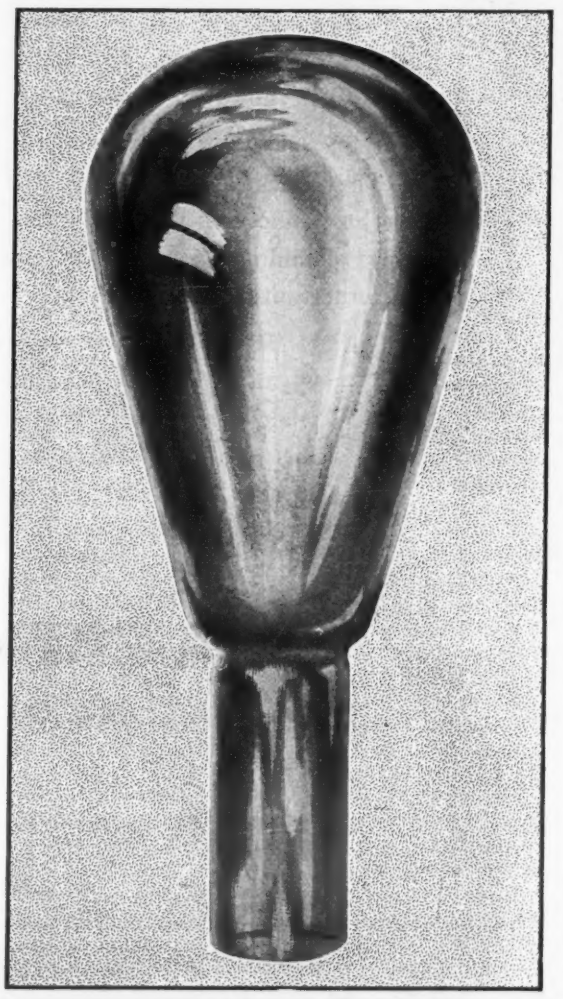

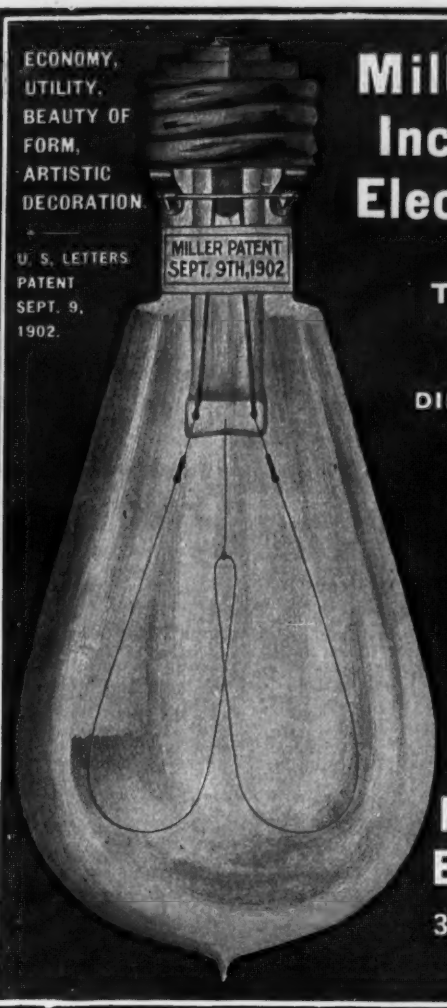

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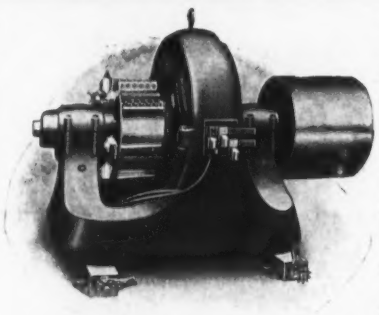

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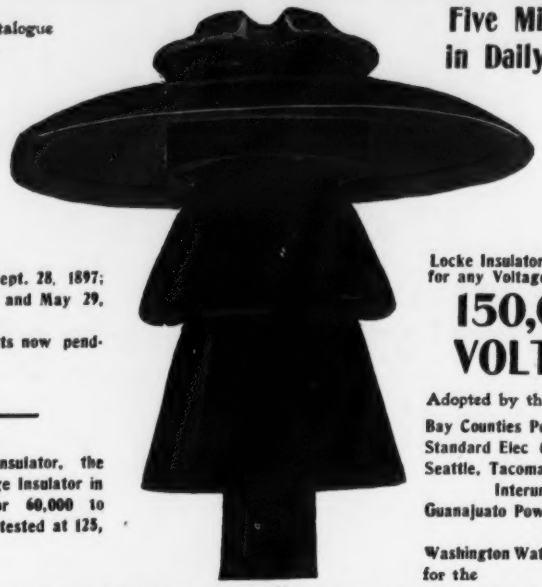

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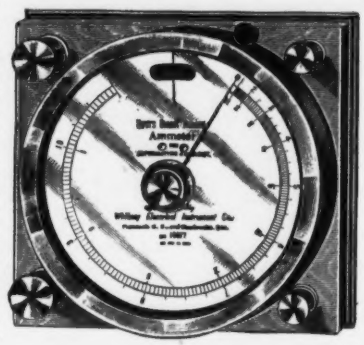

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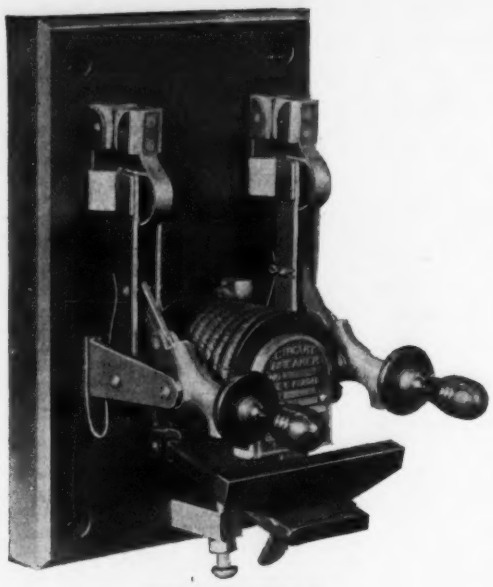

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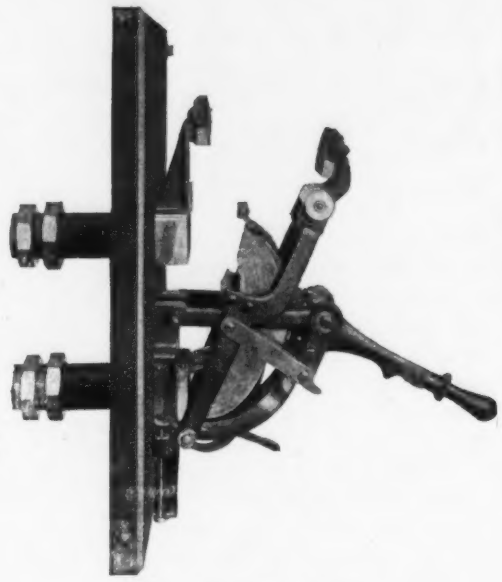

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Continued on Page 34.

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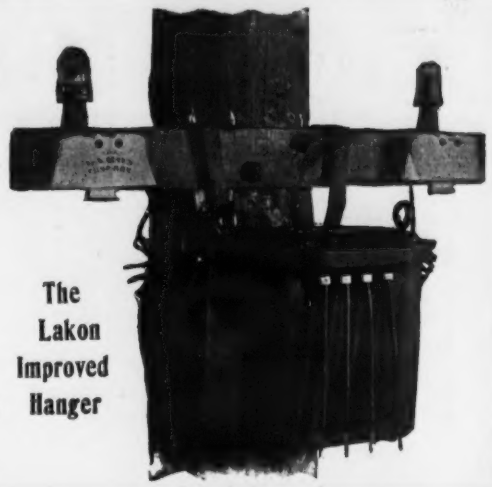

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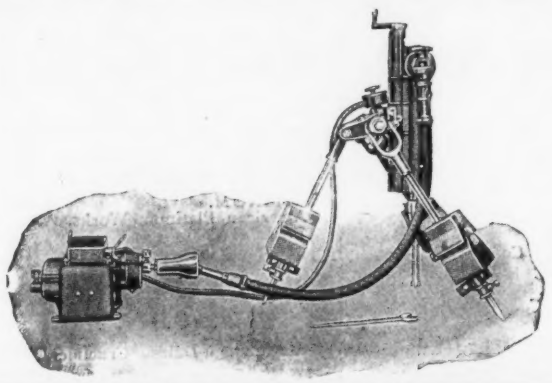

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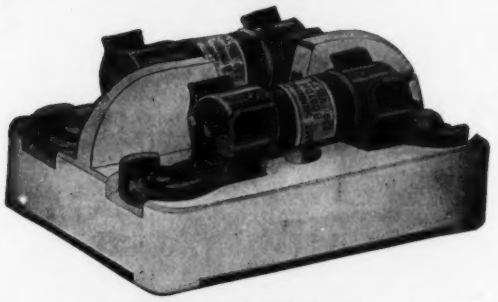

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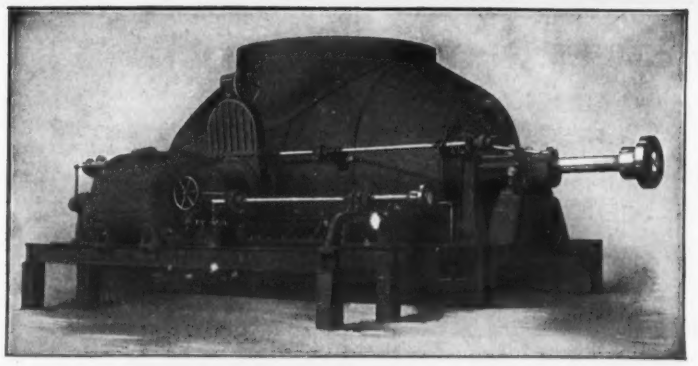

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McCullough-Dalzell Crucible Co.

NUMBERING AND DATING MACHINES.
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NUTS.
International Brass & Elec. Co.

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OIL.
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OIL AND GREASE CUPS.
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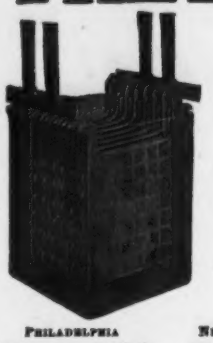

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Ewing-Merkle Elec. Co.
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Gregory Electric Co.
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Condit, Jr., & Co., S. B.
Cook, Frank B.
Crouse-Hinds Electric Co.
Cutter Electrical & Mfg. Co.
Electro-Dynamic Co.
Ft. Wayne Electric Works.
General Electric Company.
General Incandescent Arc Light Co.
Hart Mfg. Co.
Hill Elec. Co., W. S.
H. O. S. Engineering Co.
Johnson & Morton.
La Roche Co., F. A.
Renim Specialty Co.
Sterling Electric Co.
Trumbull Elec. Mfg. Co.
Zimdars & Hunt.

TACHOMETERS.
Schaeffer & Budenberg Mfg. Co.

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Bossert Elec. Const. Co.
Crouse-Hinds Electric Co.
Johnson & Morton.
La Roche Co., F. A.
Zimdars & Hunt.

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Manhattan Electrical Supply Co.
Okonite Co.
Standard Paint Co.

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Pratt & Whitney Co.

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American Electric Telephone Co.
Atwater Kent Mfg. Co.
Automatic Elec. Co.
Bissell Co., F.
Central Tel. & Elec. Co.
Clark Automatic Tel. S. B. Co.
Clark Tel. & Tel Co., Thos. F.
Conn. Telephone & Elec. Co.
Eureka Elec. Co.
Holtzer-Cabot Elec. Co.
International Tele. Mfg. Co.
Kellogg Switchboard & Supply Co.
Manhattan Elec'l Supply Co.
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Viaduct Mfg. Co.
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Rosenberg Co., A.

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Montauk Fire Detecting Wire Co.
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Safety Insulated Wire & Cable Co.
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Standard Underground Cable Co.
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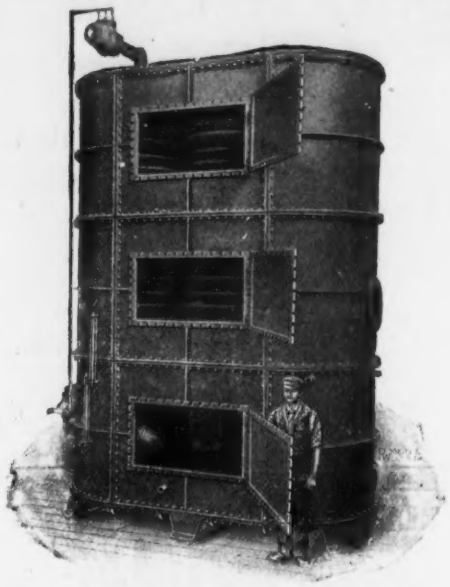

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AND THE WATER DELIVERED TO YOUR BOILERS IS HOT AND PURE, AND FREE FROM SCALE PRODUCING ELEMENTS . . .

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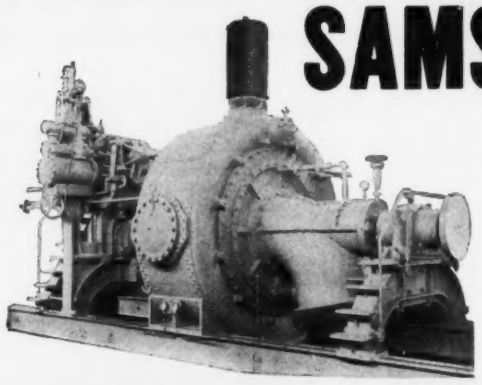

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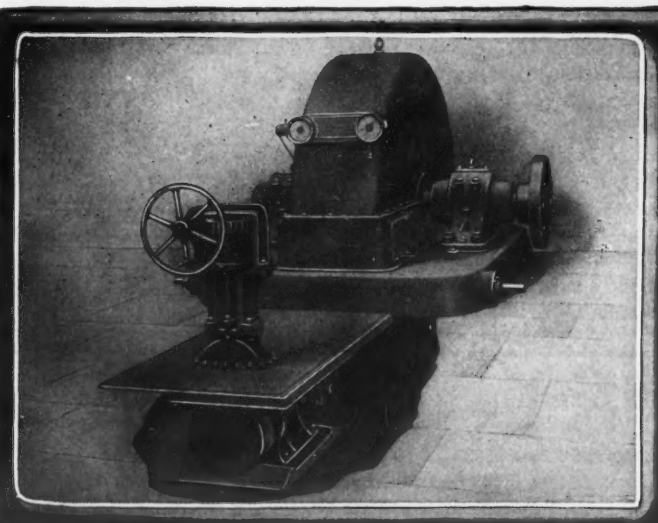

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Stands to reason that insulation is increased many fold.
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An entirely new and much-needed specialty on a new principle. Neatest possible design and absolutely safe. A free sample, of course, and you need to see it.

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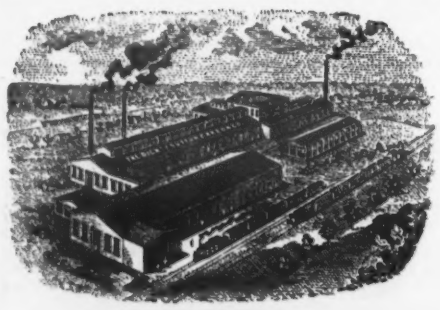

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Electric Cotton-Leather Belting
Does not SLIP Does not STRETCH —Like Leather
IS SMOOTH RUNNING ABSOLUTELY NOISELESS
and the best belting made for Electric and all high speed machinery
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WIRES AND CABLES,
FOR SUBMARINE, AERIAL, UNDERGROUND AND INTERIOR USE.
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Expert Opinions on the scope and validity of Patents

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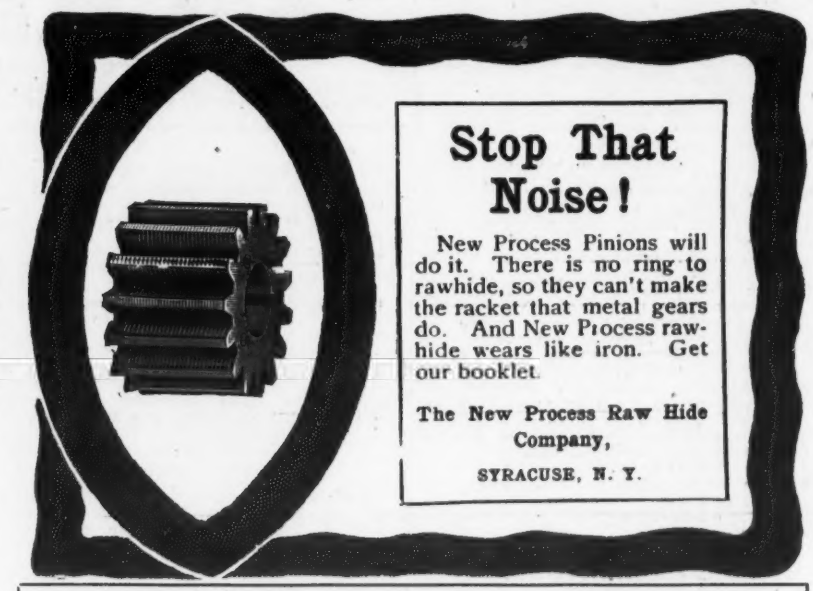
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New Process Pinions will do it. There is no ring to rawhide, so they can't make the racket that metal gears do. And New Process rawhide wears like iron. Get our booklet.
The New Process Raw Hide Company,
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FOR ELECTRICAL SPECIALTIES

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IS MORE WIDELY QUOTED ABROAD THAN ANY OTHER ELECTRICAL JOURNAL PUBLISHED

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The rate for "Position Wanted" advertisements of forty words or less is one dollar an insertion; additional words two cents each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.

POSITION WANTED.—Southern sales arrangement or position with Atlanta as a center, by man (age 33) with thorough training in practical and technical electrical practice and strong acquaintance with southern trade; experience has been in selling alternating current and direct current machinery and supplies, and in construction work, also steam work. Address No. 1211, care Electrical World and Engineer, New York.

POSITION WANTED.—By power and high tension specialist (technical, practical); 15 years' alternating and direct current experience in large central stations, consulting and manufacturing work; desire position as superintendent or engineer, etc.; executive, versatile and independent ability; central station or mammoth manufacturing establishment preferred. Address No. 1230, care of Electrical World and Engineer, New York.

POSITION WANTED.—By electrical engineer; 8 years' experience in the manufacture of direct current apparatus; desires change of location; at present with company manufacturing direct current machinery as designing engineer and superintendent; similar position preferred; can furnish references. Address No. 1219, care Electrical World and Engineer, New York.

POSITION WANTED.—As solicitor, estimator and general superintendent of electrical construction work; 10 years' experience in all classes of wiring; particularly conversant with iron conduit; willing to take part interest in attractive business; excellent references from present employer. Address No. 1224, care Electrical World and Engineer, New York.

WANTED

YOU, who are troubled with sparking and cutting of commutators, to use

The only article that will PREVENT SPARKING. Will keep the commutator in good conditon and PREVENT CUTTING.

ABSOLUTELY WILL NOT GUM THE BRUSHES . .

It will put that high gloss on the commutator you have so long sought.

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Sole Manufacturers (3)

100 WASHINGTON ST. **CHICAGO, ILL.**

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U. S. METAL POLISH

FOR POLISHING ALL KINDS OF METALS.

Sold by Dealers. Samples Free.
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WHY DON'T YOU —— Put a Little

Hare's Commutator Compound

on that Sparking Motor, and save the Commutator? Save your time too. Both cost money.

Big Stick, 35c. Enough to show you FREE.

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POSITION WANTED.—By an engineer as superintendent or chief engineer of lighting station or street railway plant, or handling construction work; 15 years' experience with A. C. and D. C. machinery, also steam and hydraulic property; open for position anywhere; highest references. Address No. 1229, care Electrical World and Engineer, New York.

POSITION WANTED.—By electrical and mechanical engineer, with wide experience installing and operating the largest plants; open for engagement after Jan. 1st; last 2½ years electrical engineer for the Colorado Fuel & Iron Co., Pueblo, Col. Plant is now closed down; age 32. Address W. K. Freudenberger, Columbia, Mo.

POSITION WANTED.—As electricain or superintendent of an electric light plant in a town of 2000 to 4000 inhabitants, by young man with five years' experience in above named capacities; technical education and strictly first class references from past and present employers. Address No. 1234, care Electrical World and Engineer, New York.

POSITION WANTED.—By electrical engineer, technical graduate, with eleven years' construction, factory and commercial experience, who seeks an engagement after January 1st; well acquainted in New York and Chicago; a position where commercial ability can be exercised preferred; highly recommended by former employers and associates. Address No. 1232, care Electrical World and Engineer, New York.

POSITION WANTED.—As electrical engineer or superintendent of electric railway or lighting company; 10 years' experience in electrical construction work and testing, erection and operation of electrical apparatus, including high tension interurban railway installations; A1 references as to character and ability; salary $150.00 per month. Address No. 1228, care Electrical World and Engineer, New York.

POSITION WANTED.—As foreman or superintendent; 15 years' experience in erecting and operating high and low tension 2-3 phase plants; able to handle men and make all tests and repairs on A. C.-D. C. motors, generators, switchboards, transformers, and storage batteries; will go anywhere, South preferred. Address No. 1231, care Electrical World and Engineer, New York.

POSITION WANTED.—By college graduate, electrical engineer, age 25; desires position with either an electrical railway company or an electric light and power plant, or with consulting and contracting engineer; have wide experience in testing A. C. and D. C. machinery; am also good draughtsman; will go most anywhere, but the West preferred; claims for salary moderate. Address No. 1233, care Electrical World and Engineer, New York.

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WANTED.—Three experienced incandescent lamp salesmen, by an old and well established company not in the Trust; applicants will please state age, experience and salary wanted. Address No. 835, care Electrical World and Engineer, New York.

(*Continued on page 55.*)

ALTERNATING GENERATORS.

60 CYCLES.

1100 or 2200 volts, 7200 Alternations.

	Lt.		Speed.
2	300	Gen. Elec., 15-K.W., comp., single phase, with exciter	720
1	500	Wood, 25-K.W., comp., iron clad armt., single phase, with exciter	720
1	600	West., 30-K.W., comp., toothed iron clad armt., single ph., with exciter	825
1	750	Wood, 37½-K.W., comp., iron clad, armt., single phase, with exciter	525
1	900	West. 45-K.W., comp., toothed armt., 2 phase, 1100 v., with exciter	720
1	1200	West., 60-K.W., toothed armt., single ph.; comp., with exciter	720
1	1500	Warren-Medberry, 75-K.W., 2 ph., ind. type, with exciter, 2200 v.	600
2	1500	West., 75-K.W., toothed armt., comp., with exciter, single phase	720
1	1500	Stan., inductor, 75-K.W., 2 phase, 1100 or 2200 v., with exciter	900
1	1500	West., 75-K.W., comp., distributed winding, 2 ph., 1100 v., with exciter	900
2	1500	West., 75-K.W., 2 ph., 2200 v., d. c. to 14x14 Gates 4-valve aut., engine, complete with exciter	300
1	1500	Wood, 75-K.W., comp., slotted armt., with exciter	600
1	2400	Gen. Elec. 120-K.W., 3 phase, 2200 or 3300 v., with exciter	600

125-133 CYCLES ALTERNATING GENERATORS.

	Lt.		Speed.
1	650	Wood, 33-K.W., comp.,	1680
1	750	West., 37½-K.W.	1650
1	750	Wood, 37½-K.W., comp.	400
1	900	Warren-Medberry, 45-K.W., inductor type	1300
1	1000	Wood, 50-K.W., comp.	1400
2	120	West., 60-K.W., toothed armt., comp.	1650
1	1500	Wood, 75-K.W., comp.	1050
	Lt.		Speed.
1	1500	Stanley, inductor type, 75-K.W., 1100 or 2200 v., 2 phase	
1	1800	West., 90-K.W., comp., toothed armt.	1500

LATEST TYPES OF (second-hand) ELECTRICAL MACHINERY

FOR SALE AT BARGAIN PRICES

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Send for our Monthly Bargain Sheet showing complete list of apparatus with NET PRICES. All machines fully guaranteed.

	Lt.		Speed.
2	2400	West., 120-K.W., comp., self-oiler, toothed armt.,	1375
1	2400	Gen. Elec., 120-K.W., type A 120, latest type, comp., toothed armt.	1070
2	2400	Gen. Elec., 120-K.W., type A S, comp., slotted armt.	1070
1	4000	Stan., inductor type, 200-K.W., 1100 or 2200 v., 2 phase	670
1	8000	West., 400-K.W., slotted armt., 3 bearings, distributed windings	445

110 TO 125 VOLT GENERATORS.

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	Lt.		Speed.
4	10	West. Elec., M. P.	1350
1	25	Triumph, M. P., comp.	1400
1	35	Crocker-Wheeler	1200
3	40	Gen. Elec., type I B	1900
1	45	Excelsior, M. P.	900
3	45	West., M. P., comp.	1800
1	45	Gen. Elec., type C E	2050
1	50	Crocker-Wheeler	1150
1	50	C. & C., comp., self-oiler	1550
1	50	Northern, M. P.	2100
3	55	Edison, self-oiler, 3-K.W.	1900
2	60	Hobart, M.P., comp., s-o.	1200
1	75	Hobart, M.P., comp.	1300
2	75	West., M. P., comp.	1650
1	80	Riker, M. P., comp., s-o.	1100
1	80	New Eng., multipolar	1450
1	80	Perrett, multipolar	950
2	80	Card, multipolar	1250
1	80	Crocker-Wheeler, comp.	1350
1	100	Card, M. P.	1000
2	100	Hobart, M. P., comp.	1500
2	100	Northern, M.P., comp.	1600
2	100	Com., M. P. comp.	1350
1	150	Eddy, M. P.	1650
1	120	West. Elec., M.P., comp.	750
1	180	Triumph, M.P., comp.	1200
1	210	Triumph, M.P., comp.	1100
1	210	Eddy, M. P.	1100
1	210	Sprague-Lundell, M. P.,	1050
1	210	Crocker-Wheeler, M. P.	1000
2	210	Edison, s-o., 12-K.W.	1500
1	250	Fuller, M. P., comp.	580
1	300	Perrett, M. P., comp.	750
1	300	Phoenix, M. P.	1100
1	300	Ahlms-Edwards, M. P.	825
2	350	Edison, 20-K.W., comp.	1400
2	350	C. & C., M.P., 20-K.W.	800
1	350	Card, M.P., comp.	800
1	400	Crocker-Wheeler, M. P.	1150
1	400	Triumph, M. P., comp.	950
1	400	Crocker-Wheeler, M. P.	875
1	400	Northern, 22½-K.W.	1000
2	450	Edison, 25-K.W., s-o.	1300
1	450	Gen. Elec., M. P., comp.	1100
1	450	Sprague-Lundell, M. P.	925
1	540	C. & C., M.P., 30-K.W.	700
1	540	Fisher, M.P., comp.	
2	540	Gen. Elec., M.P., comp.	1000
3	600	Card, M.P., comp.	850
2	700	Commercial, M. P., comp.	865
1	700	West., M. P., engine type, for direct connection, comp., 35-K.W.	375
1	750	Card, M. P., comp.	750
2	800	Edison, 45-K.W., comp.	1000
1	900	Wagner, M. P., comp.	950
2	1000	Edison, s-o., 60-K.W.	700
1	1000	Gen. Elec., 6 pole, comp., direct connection to 12x 13 Weston aut. engine, 60-K.W.	275
1	1300	Walker, M. P., 75-K.D.	600
1	1300	Card, M. P., comp.	500

	Lt.		Speed.
1	1350	Waddel-Entz, 80-K.W., d. c. to Ball engine, 15x14	265
1	1350	Ft. Wayne, comp., d. c. to 13x14 Buckeye vertical engine, 80-K.W.	275
2	1350	Gen. Elec. M. P., 6 pole shunt, d. c. to Ames tandem comp. 11x17x12 automatic engine	270
1	1800	Edison, 100-K.W., s-o.	650
2	2500	West. Elec.,M. P., comp., for d. c., brand new, 150-K.W.	240

DIRECT CONNECTED UNITS

	Lt.		Speed.
1	1000	G. E., 6 pole, comp., d.c. to 12x13 Weston aut. engine, 60-K.W., 125 v.	275
1	1350	Waddel-Entz, 80-K.W., d. c. to Ball engine, 15x 14, 125 v.	265
1	1350	Ft. Wayne, comp. d. c. to 13x14 Buckeye vert. engine, 80-K.W., 125 v.	275
2	130	Gen. Elec., M. P., 6 pole shunt, d. c. to Ames tandem comp. 11x17x12 aut. engine, 12 v.	270
1	2500	West. Elec., M.P., comp. for d. c., brand new, 150-K.W., 125 v.	240
	K.W.		Speed.
1	40	Commercial, M.P., d. c. to 11x12 aut. Chandler-Taylor engine, 250 v.	300
1	75	Siemens & Halske, Churchward type, M. P., brand new, for d. c., 250 v.	300
1	75	West., 60 cycle, 2 phase, 2200 v., d. c. to 14x14 Gates 4-valve aut. engine, complete with exciter	300

220 TO 250 VOLT GENERATORS.

	K.W.		Speed.
1	12	Crocker-Wheeler, M. P.	1000
1	12	Card, M. P., comp.	800
1	12	Westinghouse, M. P.	1400
1	15	Edison, self-oiler	1400
1	15	Crocker-Wheeler, direct connected to 25-H.P. Nash gas engine.	300
1	20	Western Electric	150
1	20	Edison, self-oiler, comp.	1400
1	20	Wagner, multipolar	1200
1	20	Keystone, M.P., comp.	950
1	20	Eddy, M.P., comp.	950
1	20	Diehl, M.P., comp.	925
1	25	Crescent, multipolar	1000

DYNAMOS ✻ MONEY SAVERS ✻ ENGINES

10 VOLT GENERATORS AND MOTORS

2—60-K.W. Edison bipolar.
2—45-K.W. Edison bipolar.
1—30-K.W. Loomis, 4 pole.
1—21-K.W. Riker, 4 pole.
1—25-K.W. Crocker-Wheeler, 4 p.
1—15-K.W. Edison, bipolar.
1—8½-K.W. Edison, bipolar.
1—6-K.W. Edison, bipolar.
1—32-H.P. Crocker-Wheeler motor.
1—15-H.P. Riker, 4 pole.

20 VOLT GENERATORS AND MOTORS

1—120-K.W. C. & C., 6 pole.
1—60-K.W. Northern Electric, 6 pole.
1—60-K.W. Edison, bipolar.
1—50-K.W. Bullock, 4 pole.
1—16-K.W. Ft. Wayne, 4 pole.
1—15-H.P. Keystone, bipolar.
1—10-H.P. Excelsior, bipolar.
1—7½-H.P. American Ball, 4 pole.
1—3-H.P. Belknap, 4 pole.

00 VOLT GENERATORS AND MOTORS

2—200-K.W. Westinghouse, 4 pole.
2—125-K.W. Westinghouse, 4 pole.
1—110-K.W. General Electric, 6 pole.
3—100-K.W. General Electric, 4 pole.
4—75-K.W. General Electric, 4 pole.
1—D 62-K.W. T. H., type D.
3—47-H.P. Ft. Wayne, 6 pole motors.
1—12-H.P. Edison, bipolar.
1—7½-H.P. American Ball, 4 p.
1—7½-H.P. T. H., type D.
1—5-H.P. General Electric, 4 pole.
1—3-H.P. General Electric, 4 pole.

DIRECT CONNECTED UNITS

500-K.W. G. E., 25 cycle, 3 phase & Allis Corliss engine.
80-K.W. Jenny, 110 v. & Russell.
50-K.W. Walker, 110 v. & Russell.
25-K.W. G. E., 110 v. & Fisher.
30-K.W. Eddy, 110 v. & Watertown.
1—15-K.W. G. E., 110 v. & Ball.

6-K.W., 4-K.W., & 3-K.W., d. c. sets (brand new). Immediate shipment.

ALTERNATING

1—300-K.W. G. E., 3 ph., 25 cycles.
1—150-K.W. G. E., type A. M., 125 cy.
2—120-K.W. G. E., type A, 125 cycles.
1—120-K.W. Westinghouse, 2000 v., 125 cycles.
1—100-K.W. G. E., Mono., 125 cycles.
1—65-K.W. Stanley, 60 cy., 2 ph.
1—60-K.W. G. E., A-10-60, 125 cycles.
1—50-H.P. G. E., 3 ph., 60 cy. motor.
1—10-H.P. G. E., 3 ph., 60 cy. motor.
1—20-H.P. West., 2 ph., 60 cy. motor.

ENGINES

20x36x48 Hewes & Phillips Corliss.
16x30x48 Hamilton Corliss.
2—11x18x24 Clark Bros., tandem.
3—11x17x14 Harrisburg, tandem.
24x48 Hamilton Corliss.
22x48 Hewes & Phillips Corliss.
20x48 Harris Corliss.
17x42 Brown of Fitchburg.
16x36 Whitehall Corliss.
18x38 Hamilton Corliss.
14x28 Delamater Corliss
13x21 Buckeye tangye bed.
13x12 Armington & Sims.
12x12 Erie Ball.
10x12 Armington & Sims.
9x8 Climax automatic.

BOILERS

3 return tubulars, 72"x18', 110 lbs.
2 return tubulars, 72"x16', 110 lbs.
1 return tubular, 66"x15', 100 lbs.
2 return tubulars, 42"x14', 100 lbs.
2—113-H.P. Sterling, 125 lbs.
2—150-H.P. Babcock & Wilcox, 150 lbs.
1—267-H.P. Abendroth & Root, 150 lbs.

Boilers **THOMPSON SON & CO., 114 LIBERTY ST., N. Y.** Equipments

MODERN ELECTRICAL MACHINERY FOR SALE.

DIRECT CONNECTED UNIT, 220 volts

50-K.W. American Ball Dynamo & Engine.

10 VOLTS DIRECT CURRENT

Dynamos or Motors

30-K.W. Bullock, M. P.
15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1—K.W. C. & C.

500 VOLTS DIRECT CURRENT

Dynamos or Motors

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Westinghouse.
5-H.P. Sprague.
2-H.P. General Elec.

220 VOLTS DIRECT CURRENT

Dynamos or Motors

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. C. & C.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½-H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
1½-H.P. C. & C.
1-H.P. Crocker-Wheeler.

ALTERNATING INDUCTION MOTORS.

2 Phase, 60 Cycles, 220 Volts

30-H.P. Type F Westinghouse.
15-H.P. Type C Westinghouse.
10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse
5-H.P. Type C Westinghouse.
3-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P General Elec.

2 Phase, 440 Volts, 60 Cycles

30-H.P. Westinghouse.
15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

3 Phase, 60 Cycles

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 220 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

Phase, 60 Cycles

7-H.P. Wagner, latest type.
½-H.P. General Elec.
¼-H.P. General Elec.

Phase, 125 Cycles

3-H.P. Wagner, latest type.
2-H.P. Wagner, latest type.
1-H.P. General Elec.
½-H.P. Emerson.
1/10-H.P. Emerson.

Large stock of small motors, auto-starters, starting boxes, rheostats, switchboards, volt-meters, ammeters, etc.

I BUY, RENT AND INSTALL.—GEORGE BENDER, 137 CENTRE STREET, NEW YORK.

K.W.			Speed.
1	25	Commercial, s-o., comp.	1380
1	30	Western Elec., M. P.	600
1	30	Triumph, M. P., comp.	950
1	37½	Keystone, M. P., comp.	800
1	40	C. & C., M. P., comp.	750
1	40	Crocker-Wheeler,	950
1	40	Eddy, M. P., comp.	850
1	40	Keystone, M. P., comp.	900
1	40	Commercial M. P., d. c. to 10x12 automatic Chandler-Taylor engine	300
1	45	Am. Engine C., M. P.	750
2	45	Edison, comp., self-oiler	1000
1	45	Gen. Elec., M. P., comp.	925
1	59	Eddy, M. P., comp.	850
1	50	Triumph, M. P., comp.	900
1	55	Fuller multipolar, comp.	750
1	70	Western Electric, comp.	585
1	75	C. & C., M. P., comp.	525
1	75	Siemens & Halske, Churchward type, M. P., brand new, for direct connection	300
1	80	C. & C., comp., self-oiler	625
1	100	Edison, comp., self-oiler	650
1	100	Commercial, M. P., comp.	750
2	220	Eddy, M. P., comp.	700
1	125	Thompson-Ryan, M. P.	375
1	125	Siemens & Halske, M. P.	
2	150	National, M. P., comp.	350
1	200	Eddy, M. P., comp.	500
1	300	Western Elec., M. P.	480

500 TO 550 VOLT GENERATORS.

K.W.			Speed.
1	60	Edison, comp., self-oiler, new armt. and commutator	700
1	62	T.-H., D 62, s-o., comp.	900
1	75	Akron, M. P., 6 pole	900
2	75	Bullock, multipolar	900
2	75	Gen. Elec., M. P., 4, comp.	700
1	100	Edison, comp.	650
1	109	Siemens & Halske, M. P.	600
3	100	Gen. Elec., M.P., 4, comp.	650
1	100	Westinghouse, M. P., 6	650
1	120	Westinghouse, M. P.	625
1	200	Gen. Elec., M. P., 4, comp., s-o., three bearings	400

ARC DYNAMOS.

Lt.	C.P.		Speed.
1 35	2000	T.-H., L D 2 ball	820
1 45	1200	Brush, No. 7.	1050
1 50	1200	T.-H., L D 12, new ball	820
2 50	2000	T.-H., M D 2, s-o., ring	820
1 65	2000	Brush, No. 8	950
1 75	1200	T.-H., M D 12, s-o,	820
1 75	1200	Wood	950
1 100	2000	Wood	600

BARGAINS IN (second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.

Lt.	C.P.		Speed.
1 125	1200	Brush, 6.6 amp.	700
2 125	2000	Brush, 9.6 amp.	500
1 125	1200	Excelsior	700

220 TO 250 VOLT MOTORS.

DIRECT CURRENT.

H.P.		Speed.
1 1	Crocker-Wheeler, self-oiler	900
1 1	Commercial, self-oiler	1200
1 1	Paragon, self-oiler	1100
1 2	Edison, self-oiler	1600
1 2½	Gibbs, multipolar	1250
1 3	Gibbs, M. P.	1400
1 3	Westinghouse, M. P.	1700
1 3½	Paragon, self-oiler	1000
1 5	Western Electric, M. P.	950
3 5	Gibbs, M. P.	1400
1 7½	Western Electric, M. P.	975
1 7½	Towle, M. P.	1050
1 7½	Commercial, M. P.	1300
1 7½	Gen. Elec., M.P., form H	800
1 10	Sprague-Lundell, M. P.	1175
1 10	Keystone, M. P.	1175
1 10	Lundell, M. P.	1060
1 15	Crocker-Wheeler, M. P.	810
1 15	Card, M. P.	700
1 15	Westinghouse, M. P.	1200
1 18	Edison, 15-K.W.	1150
1 25	Western Electric	525
1 25	Keystone, M. P.	725
1 25	Eddy, M. P.	725
1 25	Diehl, M. P.	750
1 30	Crescent, M. P.	800
1 40	Western Electric, M. P.	400
1 40	Keystone, M. P.	700
1 40	Triumph, M. P.	750
1 45	Crocker-Wheeler, M. P.	850
1 50	C. & C., M. P.	560
1 50	Eddy, M. P.	675
1 50	Keystone, M. P.	750
2 60	Edison, self-oiler	750

H.P.		Speed.
1 60	General Electric, M. P.	700
1 65	Triumph, M. P.	700
1 65	Eddy, M. P.	650
1 70	Fuller, multipolar	600
1 75	Sprague, self-oiler	500
1 85	Western Electric	500
1 100	C. & C., M.P., 6 pole	450
1 100	C. & C., self-oiler	450
1 125	Edison, self-oiler	550
1 135	Commercial, M. P.	675
2 150	Eddy, M. P.	600
2 200	National, M. P.	300

500 TO 550 VOLT MOTORS.

H.P.		Speed.
1 1	Crocker-Wheeler	1200
1 1	Diehl, self-oiler	1875
1 1	New England	1100
2 1½	Crocker-Wheeler	1550
2 2	C. & C., self-oilers	1350
1 2	New England, self-oiler	1200
1 2	Crocker-Wheeler	1100
1 2	Lundell	940
2 3	Gen. Elec., type C E	1800
2 3	Crocker-Wheeler	1100
1 3½	Roth, self-oiler, M. P.	950
1 4	Triumph, M. P.	1250
1 4	Perrett, multipolar	725
1 5	Northern, M. P.	1180
1 5	Amer. Engine Co., M. P.	1550
1 5	Westinghouse, M. P.	1500
3 5	Crocker-Wheeler	950
1 7½	Northern, M. P.	1500
1 7½	Crocker-Wheeler	1500
1 7½	General Electric, M. P.	1600
1 10	Perrett, M. P.	600
1 10	Northern, M. P.	1350
1 10	Triumph, M. P.	1100
1 10	Crocker-Wheeler	1275
1 10	General Electric, M. P.	1400
1 15	Kester, M. P.	1250

H.P.			Speed.
1	15	C. & C., self-oiler	975
1	15	Perrett, M. P.	1100
1	18	T.-H., D 15, self-oiler	1550
1	20	Kester	1400
1	20	S. & H., M. P., Churchward	900
1	20	Perrett, M. P.	700
1	20	Commercial, M. P.	900
1	25	New England, multipolar	900
1	25	Card, multipolar	500
1	35	Card, M. P., self-oiler	775
1	40	Wood, multipolar	750
1	45	C. & C., enclosed, M. P.	750
1	50	Northern, M. P.	750
1	64	Bullock, M. P., enclosed	875
1	75	T.-H., D 62, self-oiler	700
2	90	General Electric, M. P.	550
1	90	Bullock, multipolar	800
1	100	Akron, M. P.	750
3	125	General Electric, M. P.	550
1	125	Westinghouse, 6 pole	600
1	150	Westinghouse, M. P.	550

ALTERNATING CURRENT MOTORS.

SINGLE PHASE. 125-133 CYCLES.

H.P.		Speed.
1	½ Wagner, 104 v., aut.	2000
1	1 Fort Wayne, 104 volts	2500
1	1 Wagner, 208 volts, aut.	2000
2	1½ Wagner, 208 volts, aut.	2000
1	5 Wagner, 104 volts, aut.	2000
1	½ Phillips, 104 volts	1800
1	½ Holtzer-Cabot, 104 volts	2500
1	½ Emerson, 104 volts	2000
1	½ Stanley, 104 volts	2000
1	½ Wagner, 104 volts, aut.	2000
1	1 Fort Wayne, 104 volts	2500
1	1 Wagner, 208 volts, aut.	2000
1	1½ Wagner, 208 volts, aut.	2000
1	5 Wagner, 104 volts, aut.	2000

SINGLE PHASE. 60 CYCLES.

H.P.		Speed.
2	½ Phillips, 104 volts	1800
1	½ Phillips, 208 volts	1800
3	½ Phillips, 104 volts	1800
3	½ Phillips, 208 volts	1800
1	1 Phillips, 208 volts	1600
1	1 Phillips, 104 volts	1600
3	1 Wagner, 208 volts	1800
1	3 Wagner, 208 volts	1800
1	7½ Wagner, 104 volts	1800
1	15 Wagner, 104 volts, aut.	1200
2	30 Wagner, 104 volts, aut.	1200

THREE PHASE. 125-133 CYCLES.

H.P.		Speed.
1	3 General Electric, 110 volts	1875

TWO PHASE. 60 CYCLE.

H.P.		Speed.
1	1 West., type C, 110 v.	1800

CORLISS ENGINES AND BOILERS.

Engines

900-H.P. 34x60 International Power Corliss.
750-H.P. 28x48 Harris Double Eccentric Corliss.
500-H.P. 16 and 30x42 Allis Cross Compound.
450-H.P. 24x48 Brown Corliss.
400-H.P. 23x60 Geo. H. Corliss.
300-H.P. 20x48 Harris Corliss.
250-H.P. 18x48 Lane and Bodley Corliss.
200-H.P. 12 and 22x42 Atlas Tandem Compound.
175-H.P. 16x42 Allis Corliss.
125-H.P. 14x36 Putnam New Type Corliss.
85-H.P. 12x30 Lane and Bodley Corliss.
700-H.P. 28½x52 Buckeye Automatic.
600-H.P. 28½x36 Meyer Four Valve Automatic.
500-H.P. 24x48 Buckeye Automatic.
400-H.P. 16½ and 28½x27 Buckeye Cross Compound.
250-H.P. 16 and 27x16 Westinghouse Compound.
150-H.P. 15x14 Ideal Automatic.
100-H.P. 13x12 Ideal Automatic.
100-H.P. 12x20 Atlas Side Crank Automatic.
100-H.P. 12x16 Erie City Center Crank Automatic.

Boilers

1—350-H.P. Babcock & Wilcox, 150 lbs.
1—280-H.P. Babcock and Wilcox, 150 lbs.
3—275-H.P. Babcock and Wilcox, 130 lbs.
1—175-H.P. Babcock and Wilcox, 125 lbs.
1—172-H.P. Babcock and Wilcox, 135 lbs.
2—150-H.P. Babcock and Wilcox, 135 lbs.
1—250-H.P. Cahall Vertical, 160 lbs.
1—72"x18' Tubular Boiler, 130 lbs.
1—72"x18' Tubular Boiler, 125 lbs.
3—72"x16' Tubular Boilers, 100. lbs.
4—66"x18' Tubular Boilers, 110 lbs.
5—66"x16' Tubular Boilers, 100 lbs.
1—60"x18' Tubular Boiler, 100 lbs.
5—60"x16' Tubular Boilers, 100 lbs.

WHITEHEAD MACHINERY COMPANY, - - - Davenport, Iowa.

FOR SALE.

DIRECT CONNECTED.

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220 volt motor to Morse Williams freight elevator.

BELTED.

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000 volt Electro Dynamic arc dynamo, 10 amperes.
500-Lt. Edison dynamo, 110 volts.
60-amp. Westinghouse dynamo to Westinghouse engine, 110 volts.
35-amp. Sprague dynamo to Hornby Ackroyd oil engine.
600-Lt. Weston dynamo, 110 volts.
500-Lt. Edison Dynamo, 110 volts, D.C. to Brotherhood engine.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
30-H.P. C. & C. motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts, with spare armature.
15 General Electric, 2-H.P., 220 volt motors.
12 Siemens & Halske 5-H.P., 220 volt motors, 220 volts, 550 R.P.M.
2 search lights.
Large stock of smaller dynamos and motors.
Repairing of electrical machinery in all its branches.

JORDAN BROS., 74 Beekman St., N. Y.

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HART & CO.

MONADNOCK, BLDG.
CHICAGO

STATION EQUIPMENT COMPANY

204 Dearborn Street
CHICAGO, ILL.

100-K.W., General Electric, 125-V., M.P. generator, direct connected to 15½ x 16 New York Safety automatic engine.
100-K.W., Western Electric, 115-V., M.P. generator, direct connected to 16 x 16 latest type Ideal engine.
100-K.W., 125-V., Edison bi-polars.
150-K.W., 220-V., Edison bi-polars.
75-K.W., 220-V., Western Electric M.P.
120-K.W. General Electric alternators.
20 x 42 heavy-duty Allis Corliss engine.
24 x 48 Allis Corliss engine.
500-H.P., cross-compound, condensing engine, 150 lbs. steam.

Write for our new stock list, No. 42, of Station Equipments and Accessories.

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IT HAS NO GEOGRAPHICAL LIMITATIONS.

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Our Specialty **Railway Field Coils** of Every Type

The ELLIOTT BROS. ELECTRIC CO.
Cleveland, O.

B. W. PAYNE & CO.

New and Second-hand Machinery

WRITE FOR LIST.

93 Cortlandt St., NEW YORK

FOR SALE

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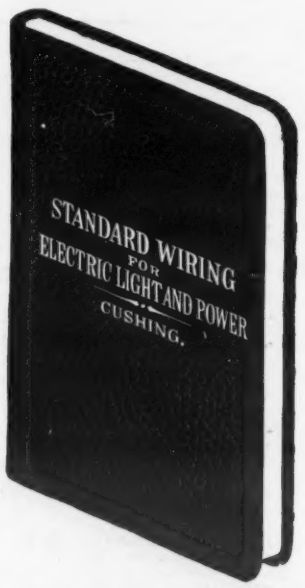

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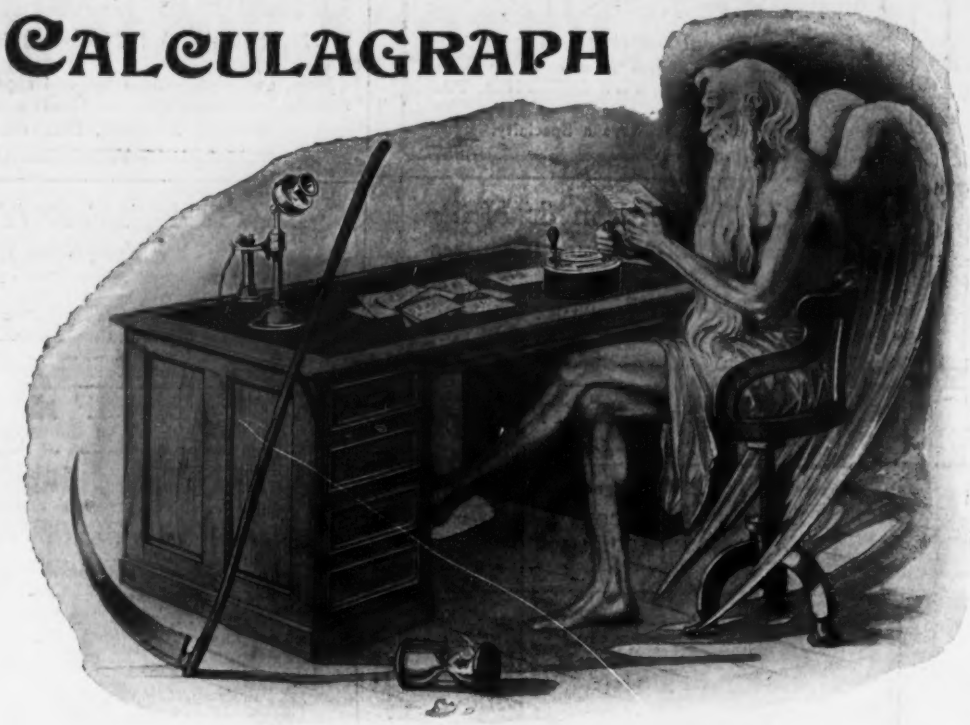

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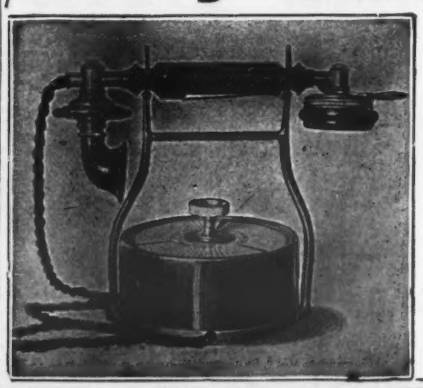

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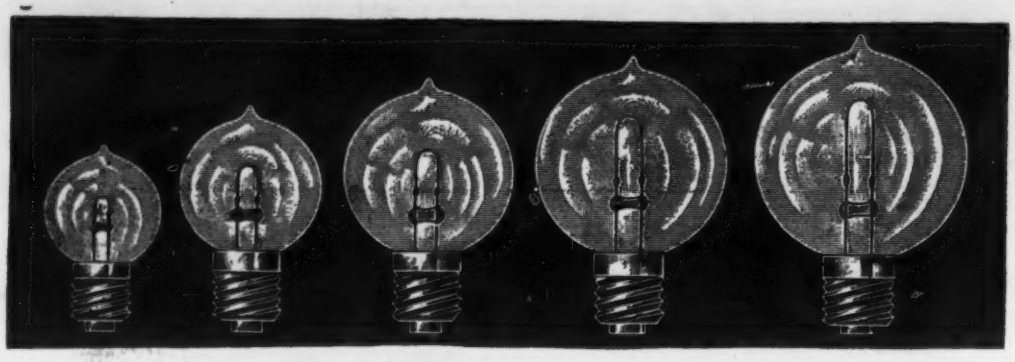

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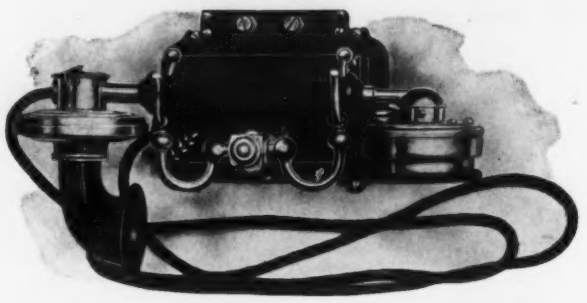

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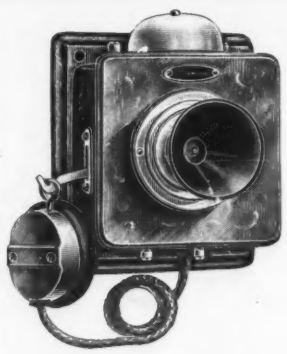

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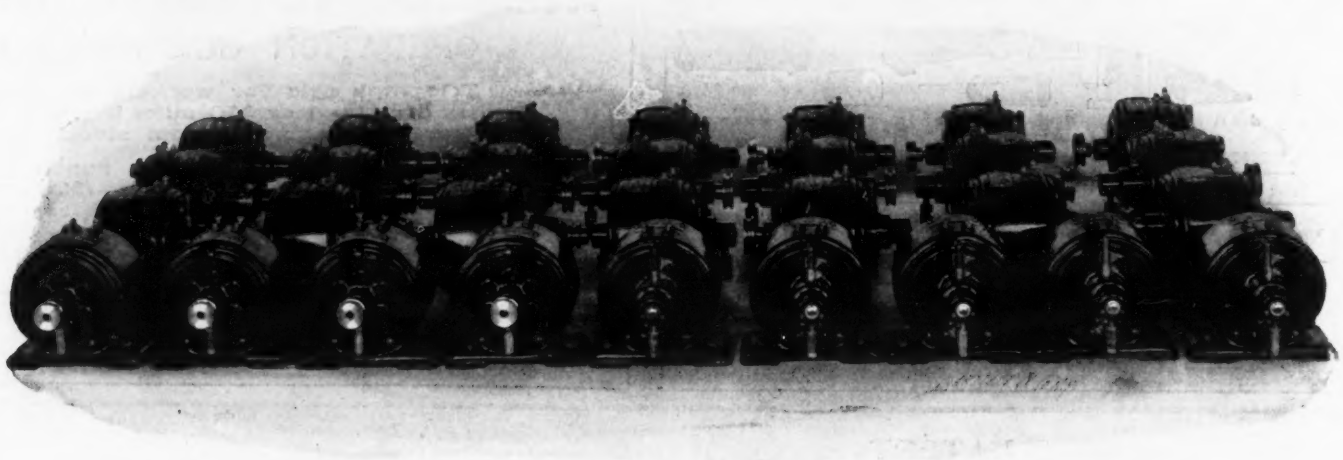

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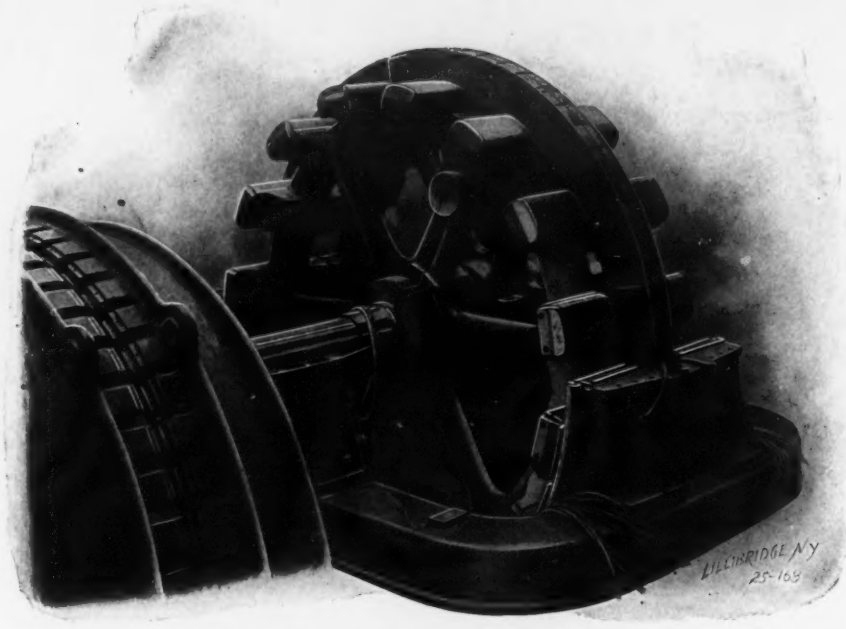

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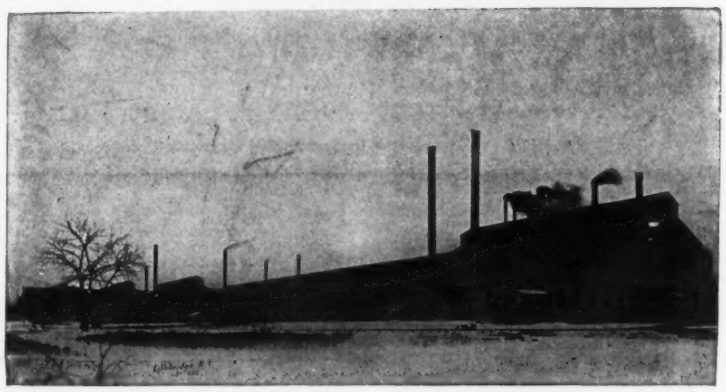

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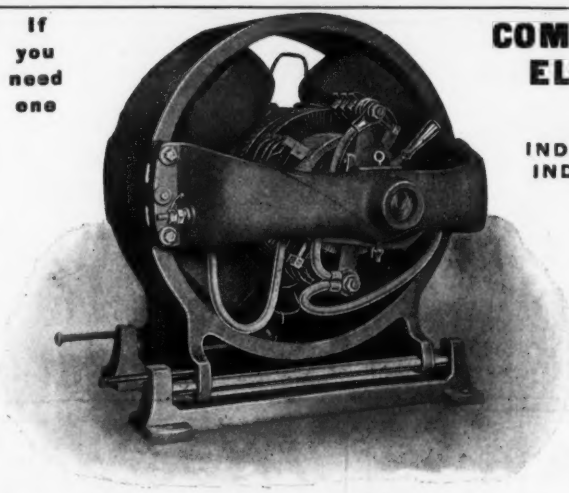

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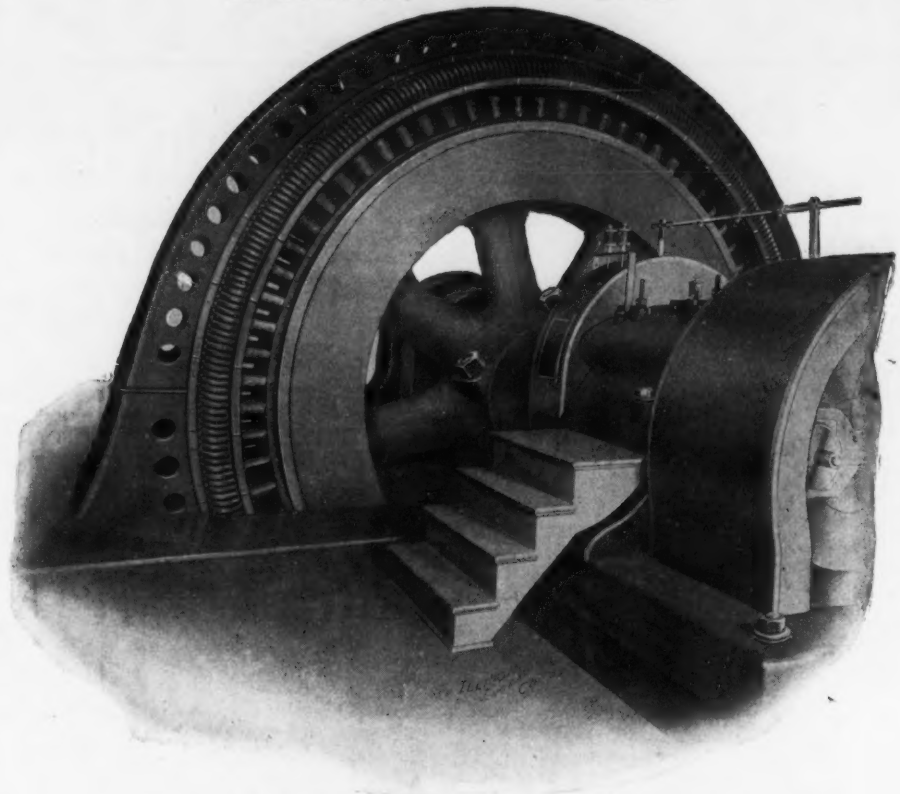

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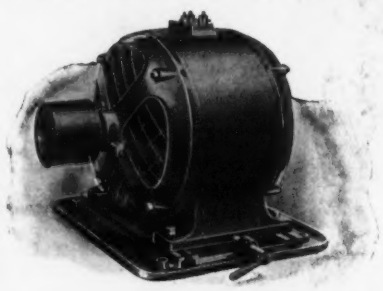

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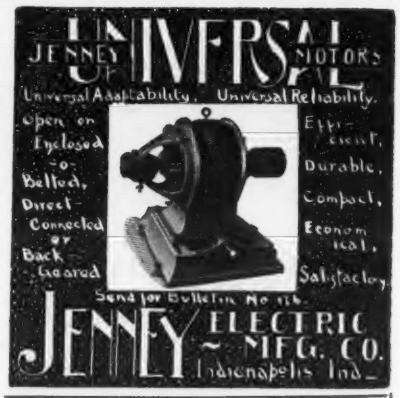
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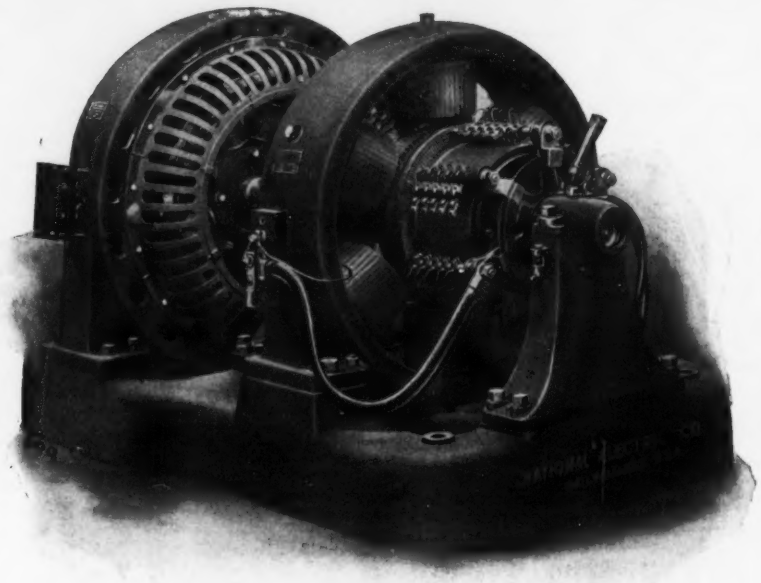

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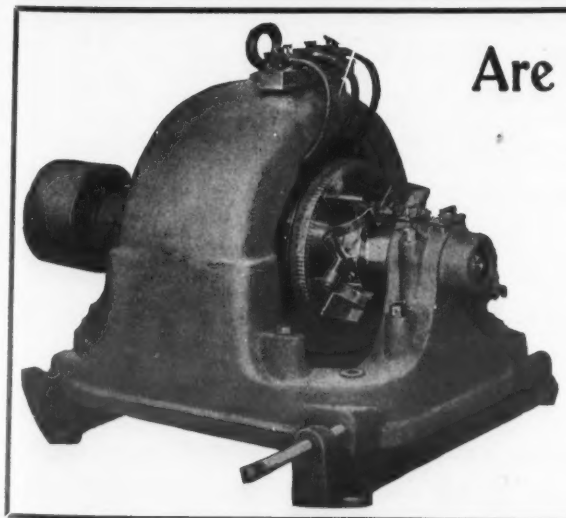

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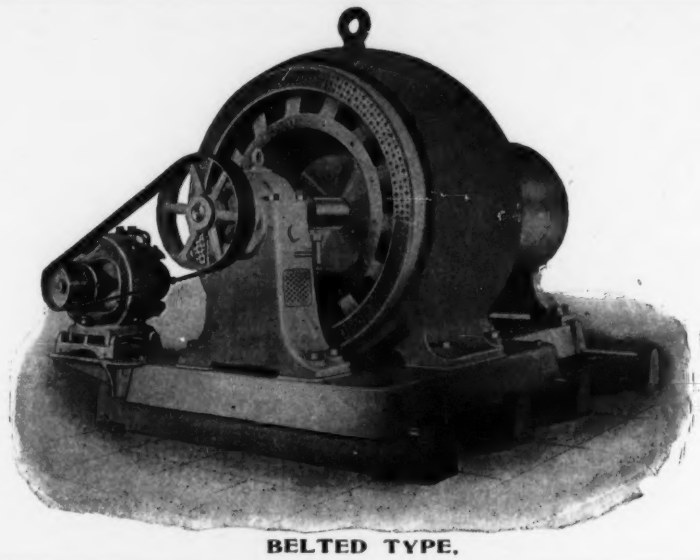

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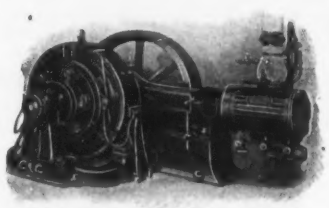

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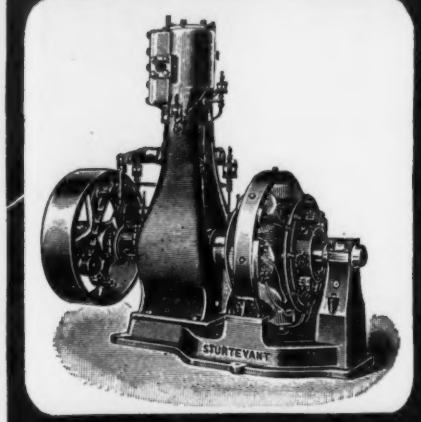

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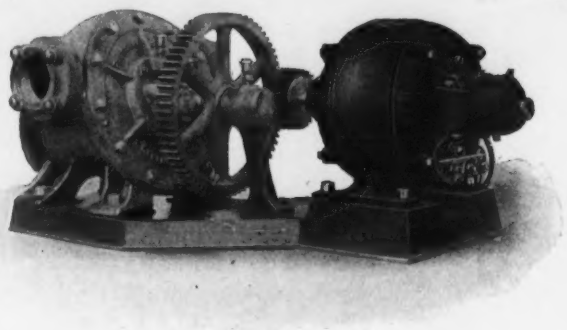

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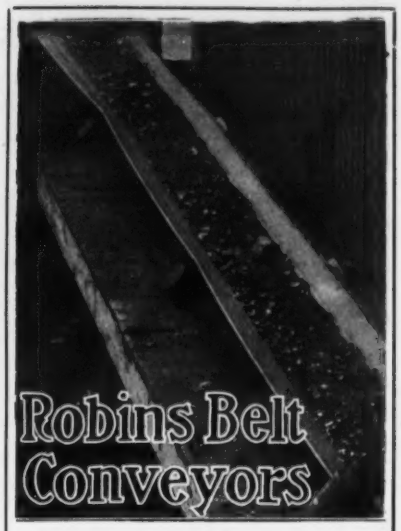

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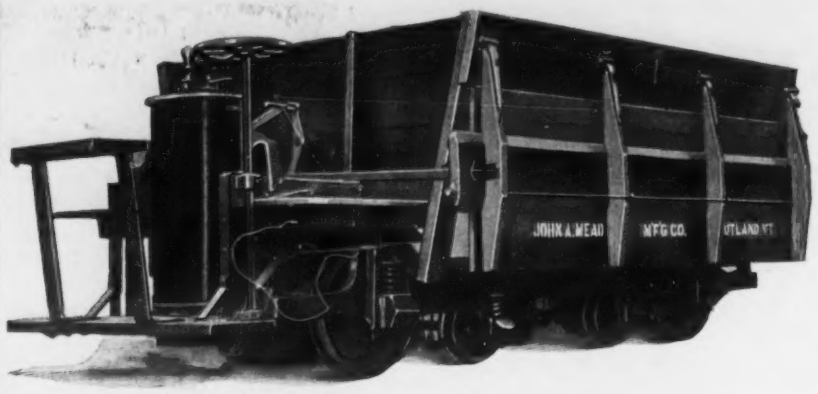

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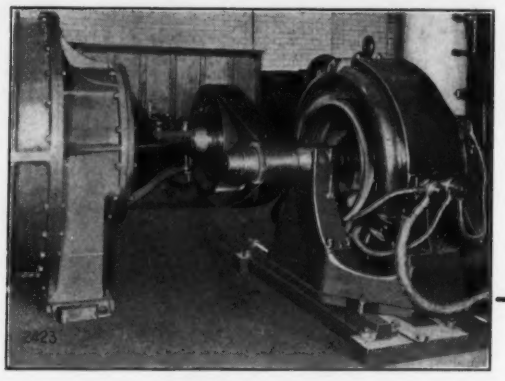

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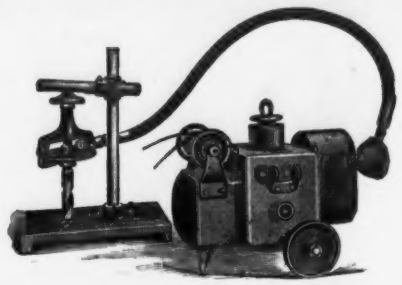

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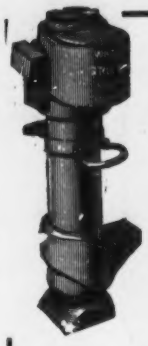

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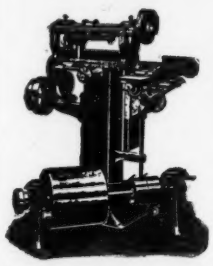

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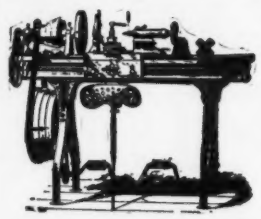

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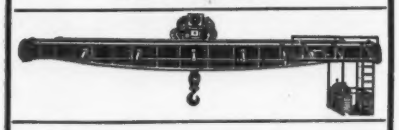

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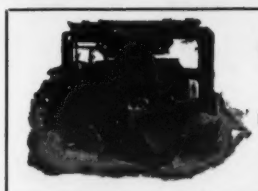

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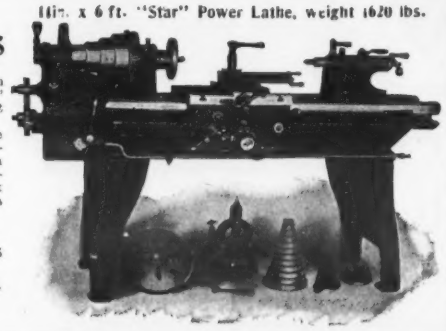

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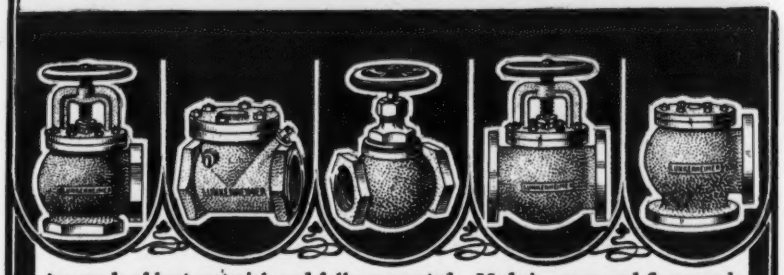

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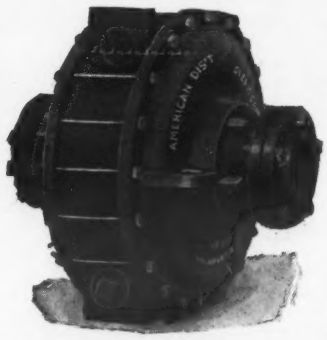

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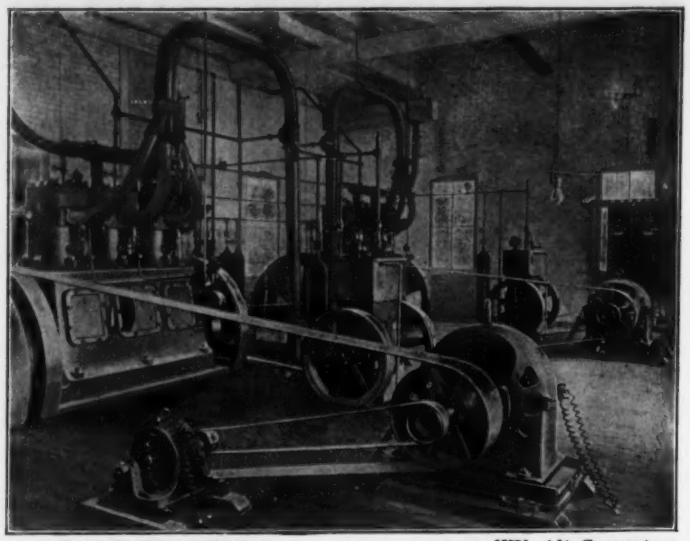

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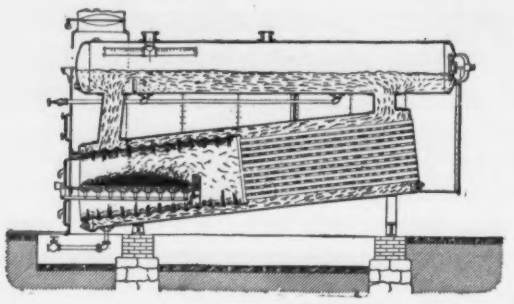

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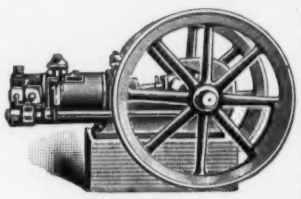

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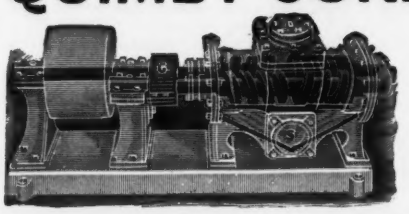

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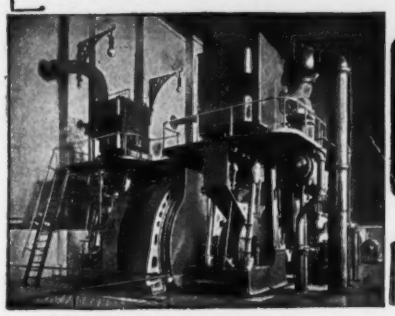

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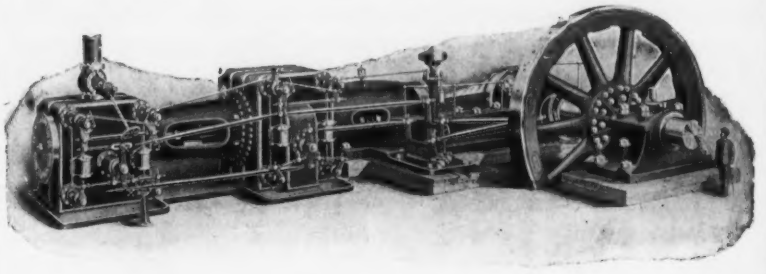

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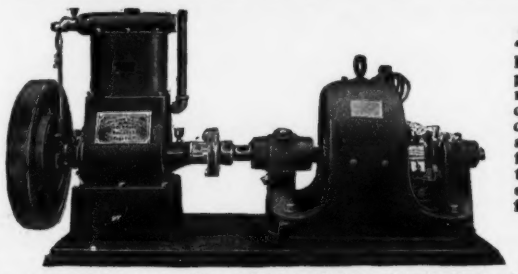

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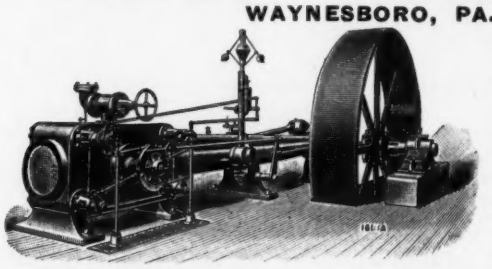

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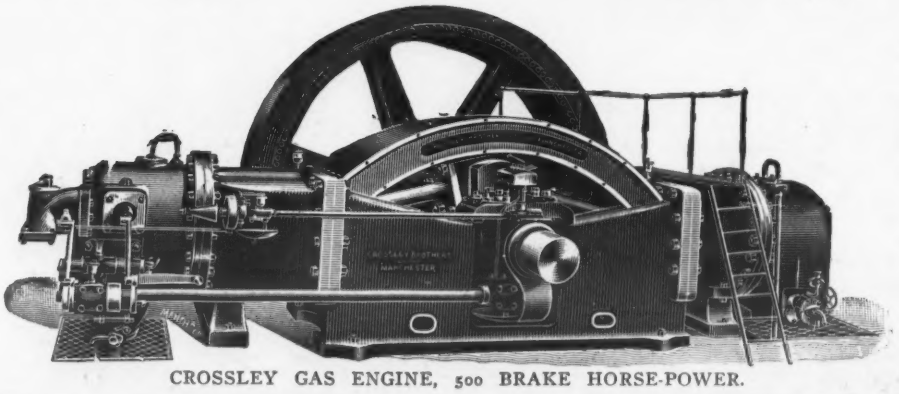

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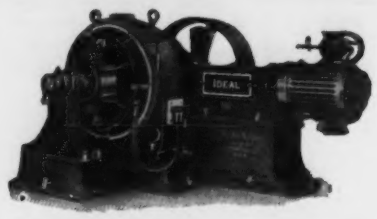

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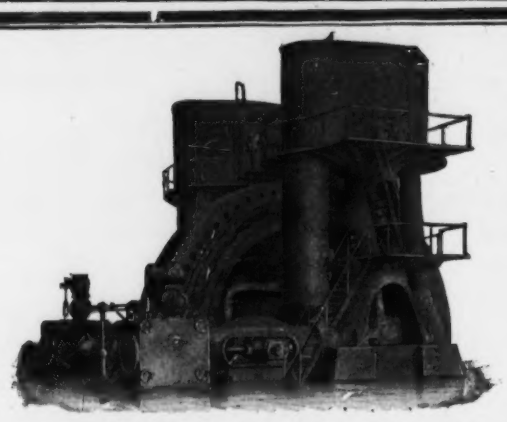

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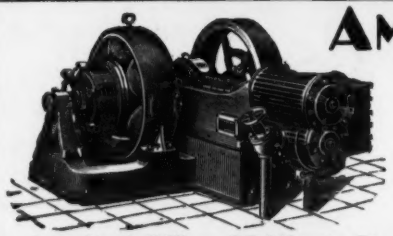

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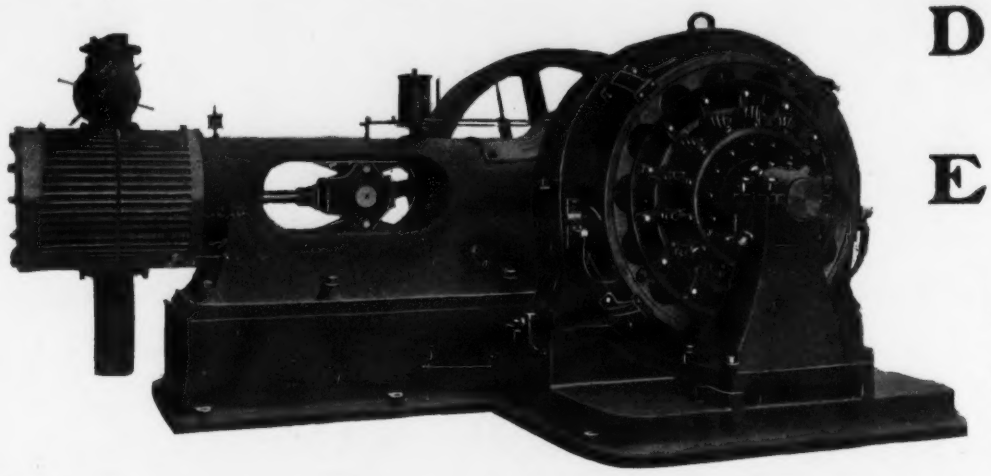

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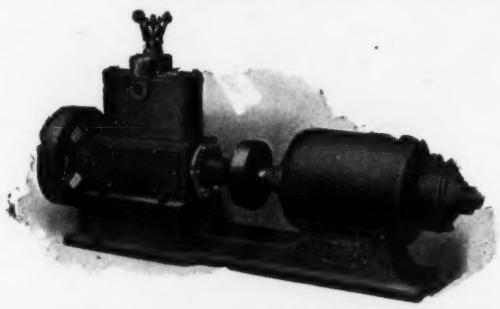

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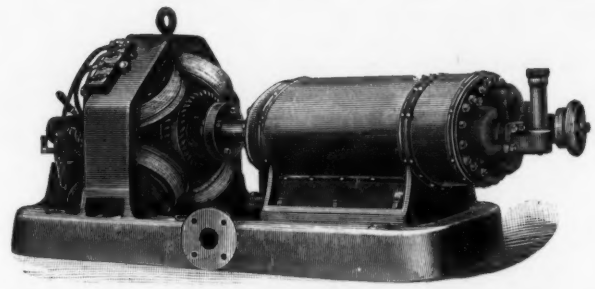

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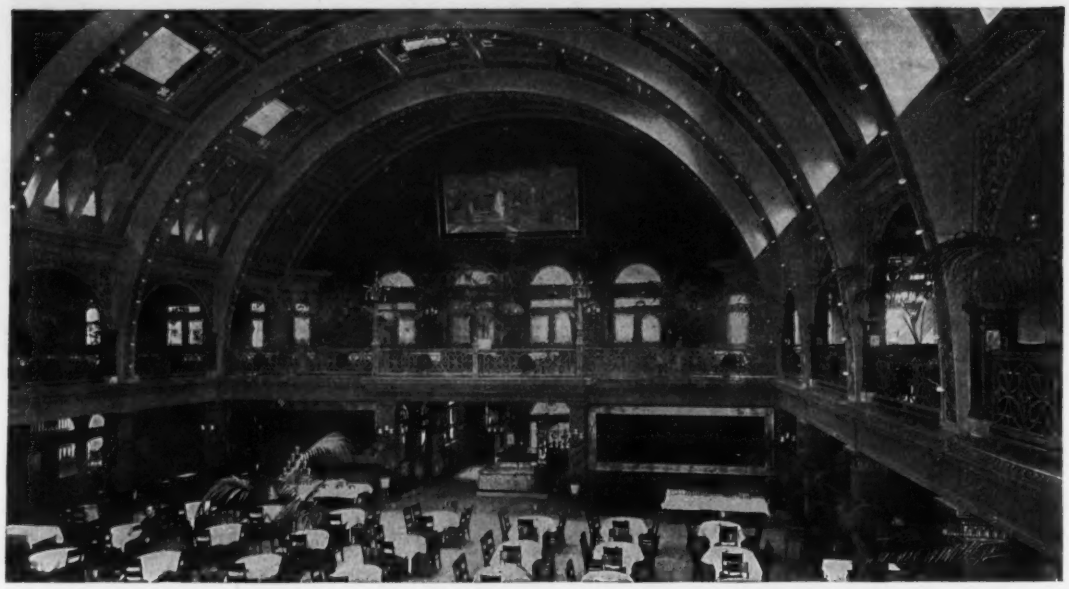

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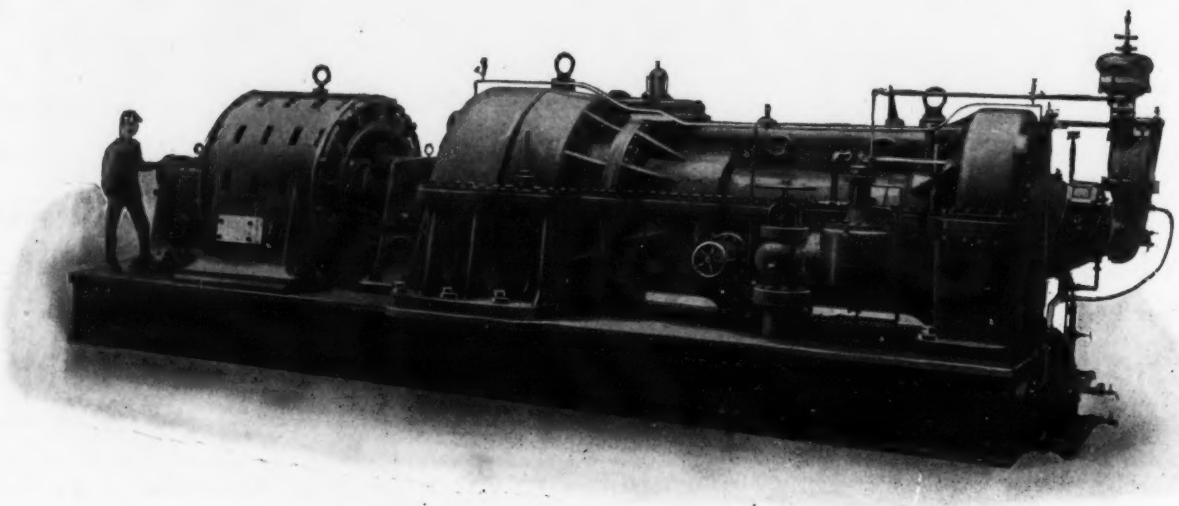

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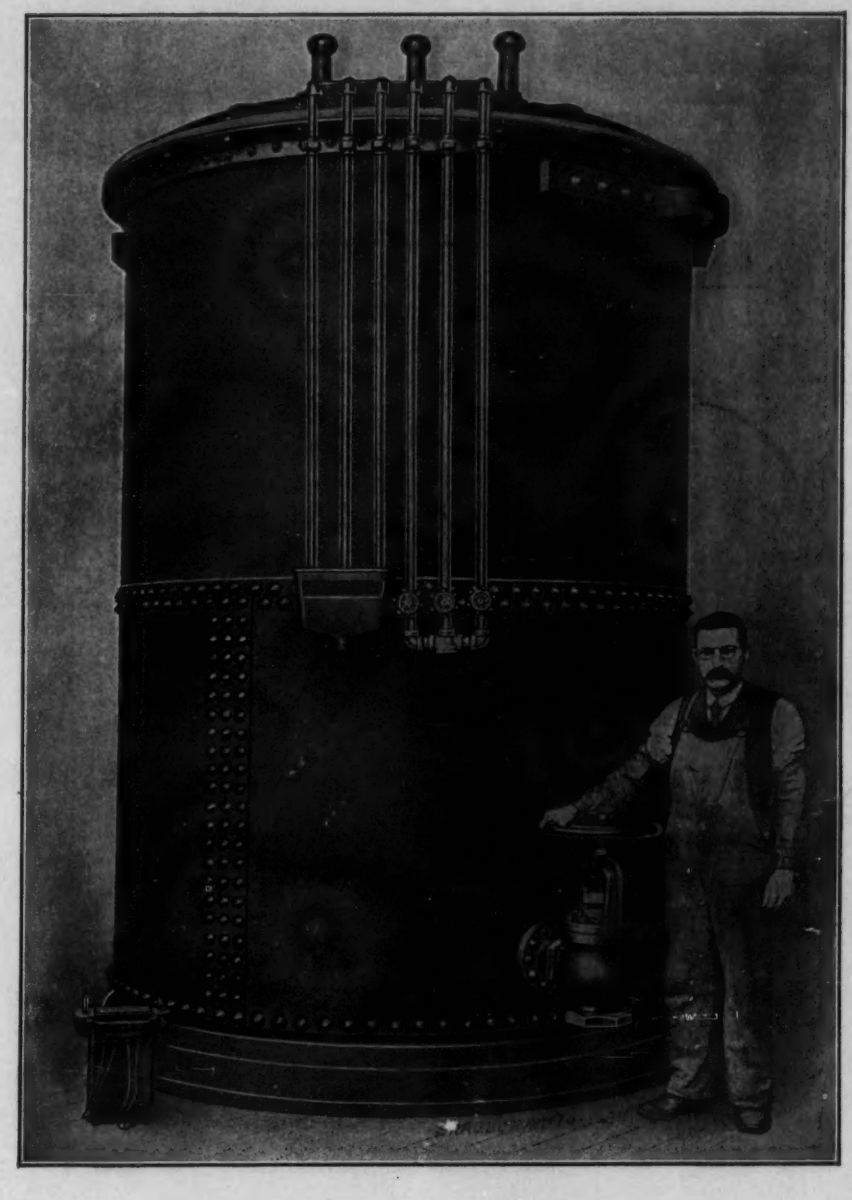

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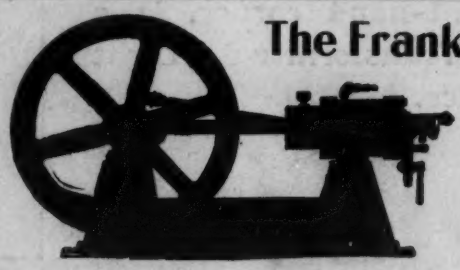

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